THE UNIVERSITY OF ALBERTA

PHYSICAL FITNESS OF WESTERN CANADIAN INDIANS

by

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A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "Physical Fitness of Western Canadian Indians," submitted by Robert John Anderson in partial fulfilment of the requirements for the degree of Master of Science.

ABSTRACT

The purpose of this study was to investigate the physical fitness status of Western Canadian Treaty Indian males between the ages of 20 and 60 years living on government reserves above 53.5°N latitude in the provinces of British Columbia, Alberta and Saskatchewan.

Twelve tests measuring lung function, strength, skinfolds, percent body fat, maximal oxygen uptake and physical working capacity were administered to 189 volunteer subjects living in eight bands in the three provinces. In addition, a questionnaire seeking information on work and recreational habits, smoking and drinking habits, and nutritional and medical status was asked of the subjects.

Subjects were classified by age group, band, province, smoking habits, driking habits and employment status for purposes of statistical analysis and comparison. The analyses included t-tests for significant differences between smokers and non-smokers on four parameters, t-tests for significant differences between drinkers and non-drinkers on three parameters, one way analysis of variance for significant differences between bands on twelve parameters and two way analysis of variance for significant differences between provinces and between age groups on twelve parameters. In addition, percentile norms were established for the entire sample on twelve parameters, and an intercorrelation matrix was established to test for relationships between the twelve parameters.

The mean scores obtained by the subjects in this study were compared to scores from other ethnic groups around the world in an attempt to classify the fitness levels of Indian males on a world basis.

The highest relationships of the twelve parameters occurred between vital capacity and one-second forced expiratory volume ($r = .66$), left and right grip and strength index ($r = .70$), back lift and strength index ($r = .84$), and percent body fat and predicted maximal oxygen uptake ($r = -.71$).

The subjects studied appeared to eat a reasonably well-balanced diet which was, however, heavily dependent on carbohydrate foods such as bread and potatoes. Almost half of the subjects were unemployed and general activity patterns indicated that most lived a relatively sedentary life. The predominant health problems were tooth decay, diarrhea and uncleanliness - problems associated with lack of bathing and sanitary toilet facilities as well as impure water supplies. No other serious medical problems were evident and all bands had the services of a part time medical doctor and full time health nurse.

Eighty-eight percent of the respondents to the questionnaire smoked cigarettes while eighty-four percent made use of alcoholic beverages.

The main recreational activities included team sports, (mainly baseball and hockey), watching television, hunting, trapping, fishing and visiting neighbors. Most of the subjects employed worked as laborers with local industries, as farmhands, or were employed by the band councils. Many subjects were also involved in vocational training programs established by the Department of Indian Affairs of the Government of Canada.

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CHAPTER I

STATEMENT OF THE PROBLEM

INTRODUCTION

Despite the lack of a universal definition of physical fitness, it is a well-established fact that there does exist individual, group, and population differences in most of the commonly measured "constituents" of physical fitness. The establishment of similarities and differences for comparative purposes is important in itself. From this basis, exploration of the causative factors involved will add further to the growing knowledge of the importance of physical exercise to the maintenance of a soundly functioning human organism.

The greatest emphasis in physiological research on physical fitness has been upon intra- and inter-individual comparisons with concomitant study on the reasons why differences exist. There is, however, growing interest in the study of population values for various measures of physical fitness. There are many reasons why we should know the levels of fitness in different population groups and in specific situations. Cumming (36:868) lists several:

1. General contribution to scientific knowledge.
2. Effects of patterns of culture on physical fitness and health.
3. Relationship of physical fitness to coronary heart disease and other specific diseases.
4. Relationship of fitness to longevity and general health.
5. Assessment of the contributions of physical fitness to mental health.
6. Child health and development in relation to physical fitness.
7. Fitness of a nation to fight a war for survival.
8. Fitness of subjects to endure extremes of physical

environments such as cold, space travel, altitude, undersea living.

9. Selection of athletes for endurance events; other events.

10. Evaluation of athletic and physical training programs.

11. Placement of men and women in industry so that physical capabilities match the demands of the job.

12. Evaluation of racial and genetic influences on physical fitness.

13. Medical separation of the fit from the unfit. Evaluation of symptoms related to heart, lungs, muscles, nervous system. Evaluation of fatigue.

14. Evaluation of rehabilitative programs.

15. Role of physical fitness in the social structure of a nation - the use of leisure time.

16. Does physical fitness delay ageing, and promote the well-being of elderly people?

The study and description of the fitness levels of various ethnic groups and populations certainly meets some of the foregoing objectives. It is the first stage in the full evaluation of the various factors operating to produce population differences in physical fitness, whether culturally or genetically determined. Group differences in fitness within genetically homogeneous populations are well demonstrated by many studies. The biological basis for these differences are, by and large, well understood and many of the externally acting forces have been identified (3). True ethnic differences are much harder to isolate and determine.

There are, unfortunately, many problems associated with a comparative study of the physical fitness levels of groups of individuals or various populations. These problems include the following:

1. Standardization of techniques and methods has not been accomplished. There are almost as many physical fitness tests as

there are testers.

2. Few studies use randomly selected samples of the populations studied and therefore representativeness is questionable.

3. Only small numbers of subjects are included which renders generalization to the whole population rather difficult.

4. Samples have been restricted to the younger age groups with little information on the older age groups.

5. There has been a failure to include the least fit as well as the most fit in the sample under study.

6. There has been a failure to report on nutrition, medical status, acitivity level, and anthropometric characteristics of the sample under study.

7. There has been a failure to report the mean age of the sample and subgroups tested.

There is an increasing abundance of normative physical fitness data appearing in the literature on various ethnic groups. Most of these studies center around single measures of physical fitness such as maximal oxygen uptake, strength, and anthropometric measures. Few studies have been conducted where more than one or two "components" of fitness are measured on the same individuals.

This author has been able to locate data on various physical fitness parameters for Arctic Indians, Eskimos, Lapps, Pascuans, Caucasians in various locales, Papuans, Bushmen, Bantus, Alacaluf Indians, Japanese, Negroes, East Indians, Polynesians and Australian Aborigines. However, no data on Canadian Treaty Indians over the age of twenty years is available. As a result, this study will provide descriptive data on physical fitness measures, along with information on nutrition, medical status, activity level and anthropometric

characteristics which will fill this gap in the world literature.

THE PROBLEM

The problem in this study was to investigate the physical fitness status of randomly selected northwestern Canadian Treaty Indian males between the ages of twenty and sixty years living on government reserves in British Columbia, Alberta and Saskatchewan.

The parameters measured were:

1. Physical working capacity expressed in kilopond meters per minute (kpm/min.) at a heart rate of 170 beats per minute as measured on a Monark bicycle ergometer. In addition, maximal oxygen uptake expressed in milliliters per kilogram body weight per minute (ml/kg/min.) was determined by the use of the Astrand-Rhyming Nomogram (12).

2. Back and leg strength expressed in pounds as measured on a dynamometer.

3. Performance arm strength measures on dips and chins.

4. Vital capacity expressed in liters as well as cubic inches, and forced expiratory volume expressed in liters per second as measured on a Collins wet vitalometer possessing a Collins electronic timing switch. Forced expiratory volume is expressed as $FEV_{1.0}$

5. Right and left grip strength expressed in pounds and kilograms as measured on a Stoelting grip manuometer. The conversion factor from kilograms to pounds is:

$$1 \text{ kg.} = 2.2 \text{ pounds}$$

6. A strength index score combining items two, three, four and five, adopted from Rogers Physical Fitness Index (56).

7. Skinfold measures expressed in millimeters (mm.) using a Harpenden skinfold caliper exerting a constant pressure of ten grams per square millimeter. Skinfolds were taken, with the subject standing, at the following four sites:

(a) triceps - in a vertical plane on the right arm between the acromion and the olecranon with the arm flexed at ninety degrees.

(b) abdomen - in a vertical plane one inch to the right of the navel.

(c) chest - one inch above and one inch to the right of the right nipple at an angle of forty-five degrees from vertical.

(d) subscapular - along the medial border near the tip of the right scapula at an angle of forty-five degrees from vertical.

8. Body fat, expressed in percent, was calculated according to the 1963 formula developed by Brozek et al. (28). This formula is:

$$\text{percent body fat} = (4.570/\text{specific gravity} - 4.142)$$

Specific gravity was calculated according to the following multiple regression equations developed by Brozek and Keys (27).

For men aged twenty to forty:

$$\text{specific gravity} = 1.1017 - 0.000282A - 0.000736B - 0.000883C$$

Where: A = abodominal skinfold (mm.)
B = chest skinfold (mm.)
C = triceps skinfold (mm.)

For men aged forty to sixty:

$$\text{specific gravity} = 1.0967 - 0.000315A - 0.000393B - 0.000598C - 0.00017D$$

Where: A = subscapular skinfold (mm.)
B = chest skinfold (mm.)
C = triceps skinfold (mm.)
D = relative body weight

9. A questionnaire seeking information on work habits, recreational habits, and nutritional and medical status was administered at the completion of the above tests. A copy of the questionnaire appears in the appendix.

SUBSIDIARY PROBLEMS

The subsidiary problems in this study were to investigate:

1. The difference between the various bands on the parameters measured.

2. The difference between the Indians in each of the three western provinces on the parameters measured.

3. The difference between the age groups in each of the provinces on the parameters measured.

4. The difference between smokers and non-smokers on selected parameters.

5. The difference between drinkers and non-drinkers on selected parameters.

6. The difference between those employed and those not employed on the parameters measured.

7. The interrelationships of all parameters measured.

8. Percentile norms for each parameter.

MAIN HYPOTHESIS

In the problem, the null hypothesis asserts that no differences exist at the .05 level of significance between the mean scores of the age groups tested.

The alternate hypothesis asserts that differences do exist at the .05 level of significance between the mean scores of the age groups tested.

SUBSIDIARY HYPOTHESES

1. There will be no differences at the .05 level of signif-

icance between the mean scores of the bands tested.

2. There will be no differences at the .05 level of significance between the mean scores of Indian males in the three provinces of British Columbia, Alberta, and Saskatchewan.

3. There will be no differences at the .05 level of significance between the mean scores of each age group in each of the three provinces.

4. There will be no differences at the .05 level of significance between the mean scores of smokers and non-smokers.

5. There will be no differences at the .05 level of significance between the mean scores of drinkers and non-drinkers.

6. There will be no differences at the .05 level of significance between the mean scores of those employed and those not employed.

DELIMITATIONS

1. This study is delimited to a sample of volunteer western Canadian Indian males between the ages of twenty and sixty years, living between 53.5°N and 60°N latitude in the three provinces of British Columbia Alberta, and Saskatchewan.

2. Only bands which were accessible by car were included in the sampling procedure.

3. Testing was limited to the period of July 12, 1971 to August 13, 1971.

4. The order of testing was the following:

(a) height
(b) weight
(c) right grip
(d) left grip
(e) leg lift
(f) back lift
(g) chins

(h) dips
(i) skinfolds
(j) forced expiratory volume and vital capacity
(k) PWC_{170}
(l) Questionnaire

7. Subjects were not tested if there were any apparent medical contra-indications.

LIMITATIONS

1. No control could be made over the environmental conditions existing at the time of testing.

2. The subjects were tested at different times of the day.

3. Subjects were unfamiliar with the test items.

4. Only bands which gave consent to the study were tested.

5. Only volunteer subjects were used.

DEFINITION OF TERMS

1. Canadian Treaty Indians - These are Indians resident on approved Government of Canada reservations born of parents who are both of the Indian race.

2. Indian Band - The name referring to a separate community of Indians occupying one or more reserves of land set aside for its use and benefit by the Government of Canada. Members of the same band usually share a common linguistic and cultural background.

3. Forced Expiratory $Volume_{1.0}$ - This is the volume of gas that can be forcefully expired in one second after a maximal inspiration. It is expressed in liters per second. In a normal individual this value is usually 83 percent of the vital capacity (34:225).

4. Vital Capacity - This is the maximum volume of gas that

can be expelled from the lungs following maximal inspiration and is expressed in liters.

5. Kilopond Meter - Commonly expressed as kpm/min.; one kilopond (kp) is the force acting on the mass of one kilogram at normal acceleration of gravity.

6. Strength Index - This is a composite score obtained by summing the scores on vital capacity (cu. in.), right and lift grip (lbs.) back and leg lift (lbs.) and arm strength.

7. Arm Strength - This is a score adopted from Rogers Physical Fitness Index and is calculated from the following formula:

Arm Strength = (number of chins + number of dips) x (W/10 + H - 60)

Where: W = weight in pounds
H = height in inches

8. Specific Gravity - This is the ratio of the density of the body to the density of water where density is mass per unit volume. Specific gravity will be calculated from the formulas of Brozek and Keys (cited 27).

9. Percent Body Fat - This is the percentage of gross body weight which is made up of fat tissue. It is calculated according to the formula of Brozek et al. (cited 28) which is:

Percent Body Fat = 100(4.570/specific gravity - 4.142)

10. Predicted Maximal Oxygen Uptake - This is an indirect measure of the maximal amount of oxygen that can be processed by an individual under strenuous exertion, and will be determined by the use of the Astrand-Rhyming Nomogram (cited 12) from values obtained on a submaximal bicycle ergometer test. The heart rate and work load values at the eighth and twelfth minutes were used to determine

maximal oxygen uptake, while the mean of these two values was corrected for age and used as the final result.

11. Age Groups - In this study subjects' ages were taken to the nearest year on the day of testing. The subjects were grouped into the following age categories:

(a) 20 - 29 years
(b) 30 - 39 years
(c) 40 - 49 years
(d) 50 - 62 years

12. Employed Persons - This includes all people who said they have been working steadily for six months or more during the year preceeding the day of testing. Those who said they have worked less than this were classified as unemployed.

13. Smokers - For purposes of the analyses in this study, smokers are those persons who said they smoke one-half package or more of cigarettes per day. Those who said they smoke less than this were not included in the analyses.

14. Drinkers - This includes those who said they use alcoholic beverages on a regular basis (at least once per week).

CHAPTER II

REVIEW OF THE LITERATURE

INTRODUCTION

Man has been interested in his state of physical fitness since the beginning of time. Shephard (70) presents a good historical review of this interest. Great physical feats were required of man in order to obtain food, create shelter, and survive. The old phrase, "survival of the fittest", attests to the importance of this important human quality.

The last hundred years has witnessed a tremendous increase in research towards understanding the complex phenomenon of physical fitness. This complexity is revealed in the lack of a universal definition of what the term implies.

In reviewing the literature pertinent to this study, the author has limited the review to those studies which present normative data which might be used for comparative purposes. Research concerned with problems of test methodology, validity, and causative factors will not be reported. However, the interested reader is referred to Astrand and Rodahl (13), Brozek (21, 24) and Keys (51), and Hettinger (46) and Kroemer (53, 54, 55), for comprehensive reviews and further references on the areas of maximal oxygen uptake, skinfolds and body fat, and strength, respectively.

The following review will present selected studies reporting normative data on males in the areas of maximal oxygen uptake, skinfolds and body fat, vital capacity and strength.

Due to the great diversity of methodology, samples, statistical

treatment, environmental conditions and terminology, caution is advised when using the data for strict comparative purposes.

The strength data collected in this study will be combined into a strength index which can be easily compared to the table of norms prepared by Frederick Rand Rogers reprinted in many measurement texts.

In addition, the normative tables compiled by the Research Committee of the Canadian Association for Health, Physical Education and Recreation (31) will be used for comparative purposes on grip strength.

MAXIMAL OXYGEN UPTAKE

Various individuals (4, 8, 11, 12, 13, 37, 47, 70, 71, 84) are of the opinion that during heavy prolonged work maximal oxygen uptake is the best measure of physical fitness or work capacity. Maximal oxygen uptake means the ability of the cardio-respiratory system to take up, transport, and give off oxygen to the muscle tissues for the performance of muscular work. Robinson (65) was the first to study maximal oxygen uptake (MVO_2) in a large group of people of various ages. The data reported by Robinson for maximal oxygen uptake appears in Table I.

TABLE I

MAXIMAL OXYGEN UPTAKE
(ROBINSON - CAUCASIANS)

Age Range	MVO_2 (ml/kg/min.)
20 - 29	53
30 - 39	41
40 - 49	40
50 - 59	37
over 60	30

[illegible]

[illegible]

[illegible]	[illegible]

Since Robinson's early study, many investigators have obtained maximal oxygen uptake data on different groups of people. This data can be used, with limitations, for comparative purposes.

Astrand (7) made determinations of oxygen uptake and heart rate at submaximal and maximal work using both a Krogh and von Dobeln bicycle ergometer. All subjects were physically active and all maximal uptake determinations were made from expired gas samples collected during the last minutes of work. The summarized data appears in Table II.

In another study, Astrand (10) studied nine men 56 - 68 years of age, who were all considered well-trained, accustomed to heavy exercise, and well-motivated. None of the subjects were experienced in bicycle riding. The bicycle used was of the von Dobeln type and the pedal frequency was set by a metronome at 50 revolutions per minute (rpm). The work period for each load was usually five to eight minutes. During the last minutes of each workload, oxygen uptake was determined by the Douglas bag method - the mean values from two successive bags were used in the case of the submaximal loads. The highest value was taken as the maximum value if the second bag showed significantly higher values than the first one. Gas analyses were made by the Haldane technique. The heart rate was determined during each minute of work by measuring the time for 30 beats as recorded on an electrocardiogram (ECG). Vital capacity was measured on two different occasions at rest, using a Collins spirometer. The mean value was reported for vital capacity and appears in Table XLIV on page 57. The maximal oxygen intake value reported in this study appears in Table III.

TABLE II

MAXIMAL OXYGEN UPTAKE
(ASTRAND - ACTIVE CAUCASIANS)

Age Range	Number of Subjects	MVO_2 (ml/kg/min.)
20 - 29 Mean = 26.5	4	52.2
30 - 39 Mean = 34.8	13	39.8 ± 7.3*
40 - 49 Mean = 42.6	9	39.2 ± 5.5
50 - 59 Mean = 53.3	37	33.1 ± 4.9
60 - 69 Mean = 62.9	8	31.4 ± 5.3

*Mean ± standard deviation

TABLE III

MAXIMAL OXYGEN UPTAKE
(ASTRAND - WELL-TRAINED CAUCASIANS)

Age Range	Number of Subjects	MVO_2 (ml/kg/min.)
56 - 68 Mean = 60.2	9	30.1

Wyndham et al. (84) studied three bushmen from the Kalahari Desert and twenty-three Bantu subjects from South Africa on a step test, one hour after rest. They stepped on and off a stool one foot in height for 30 minutes at each of three rates; six, 12 and 24 times per minute. No rest was allowed between each new workload. Oxygen consumption was measured by collecting expired air in a Douglas bag over a five minute period between the tenth and fifteenth minute. Gas analysis was made in a Haldane machine while heart rates were measured with an ECG or with a stethoscope. The maximum oxygen intakes were based on heart rates counted at the thirtieth minute and are summarized in Table IV.

TABLE IV

MAXIMAL OXYGEN UPTAKE
(WYNDHAM - BANTU AND BUSHMEN)

	Age Group	N	MVO_2 (ml/kg/min.)
Bushmen	20 - 29	3	47.1 ± 6.98*
Bantus	20 - 29	23	48.0 ± 1.96

*Mean ± standard deviation

Naughton and Nagle (59) studied ten men from the Y.M.C.A. in Oklahoma for maximal oxygen uptake on a treadmill according to the method of Balke (14). Each subject was taught how to walk on the treadmill and was given a trial walk. The subjects rested for five minutes before performing the standard test procedure. Walking was terminated when the pulse rate reached 180 beats per minute or when

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

the subject exhibited signs of dypsnea, fatigue, or claudication. The maximal oxygen uptake presented in Table V is the value obtained after seven months of physical training. (The pre-training mean value was 31.3 ml/kg/min.)

TABLE V

MAXIMAL OXYGEN UPTAKE
(NAUGHTON - U.S. CAUCASIANS)

Age Group	N	MVO_2 (ml/kg/min.)
40 - 49 Mean = 41.0	10	36.1*

*No standard deviation was reported.

Andersen et al. (6) studied 63 well-trained cross-country skiers, 17 office workers and 21 industrial workers on a bicycle ergometer, and maximal oxygen uptake and heart rate were determined. All subjects were between 50 - 59 years of age and their maximal oxygen uptakes appear in Table VI.

Williams et al. (82) in a study of 23 Bantu male subjects used a bicycle ergometer to obtain maximal oxygen uptake data after the subjects had participated in a strenuous training program for three months. Expired air was collected by means of the Douglas bag technique using a face mask with low resistance air valves. The volume of expired air was metered on a Tissot spirometer and air samples were analyzed on a Beckman E2 analyser. The duration of work at each work rate was three minutes and each work rate was repeated on three different occasions. The mean value of these three measures of maximal oxygen uptake appear in Table VII.

TABLE VI

MAXIMAL OXYGEN UPTAKE
(ANDERSEN - TRAINED CAUCASIANS)

Group	Age Group	N	MVO_2 (ml/kg/min.)
Cross-country Skiers	50 - 59 Mean = 54	63	48.0 ± .33*
Office Workers	50 - 59 Mean = 53	17	36.0 ± 1.0
Industrial Workers	50 - 59 Mean = 55	21	34.0 ± 1.09

*Mean ± standard deviation

TABLE VII

MAXIMAL OXYGEN UPTAKE
(WILLIAMS - BANTU)

Age Group	N	MVO_2 (ml/kg/min.)
20 - 30 (estimated)	23	50.8*

*Standard deviation was not reported.

In another study, Wyndham et al. (83) used eighty fit, young active Caucasian men living in South Africa. The subjects rested for twenty minutes prior to the testing and resting pulse rates were taken. The subjects were allowed to practice on a treadmill after a short explanation of the experiment. An Edwards rubber mask was fitted as well as ECG electrodes. Each subject was tested at three workloads which could be completed without undue stress. The workloads occupied seven minutes each and were chosen so that the subject's heart rate did not exceed 150 beats per minute after six minutes of work. The results obtained were used to plot oxygen consumption in liters per minute against work rate and the maximal oxygen uptake was estimated by extrapolation. Three additional maximal runs were carried out and a graph obtained for each individual included all six tests. The maximum oxygen uptake was taken to be the mean of three points on the asymptote on condition that these three oxygen intakes did not vary by more than .15 liters per minute. Expired air was collected from the fifth to the seventh minute in the case of the submaximal runs and from the second to the third minute in the case of the maximal runs. Resting intervals were determined by the time taken for the pulse rate to return to normal after exercise. The mean maximal oxygen uptake of the subjects is summarized in Table VIII.

TABLE VIII

MAXIMAL OXYGEN UPTAKE
(WYNDHAM - SOUTH AFRICAN CAUCASIANS)

Age Group	N	MVO_2 (ml/kg/min.)
20 - 29	80	47.7 ± 3.79*

The ages were not reported but it is estimated by this author that the mean age was between 20 - 29 years.

*Mean ± standard deviation

[illegible]

Astrand (9) studied 81 truck drivers employed by breweries in Stockholm. Their daily work was considered to be quite heavy. The work test was carried out on a Krogh bicycle ergometer with a continuous registration of pedal frequency. Each subject was tested on two separate occasions. The objective was for each subject to work two times with a workload of 600 kpm/min., one or two times with a work load of 900 kpm/min. and, if possible, one or more times with a higher workload. The time of work at each load was approximately six minutes. During the last experiment, the subjects attempted to reach their maximal levels. After a "steady state" was reached with regard to the heart rate, the oxygen intake was determined at each work load by the Douglas bag method. The heart rate was determined each minute by using a stethoscope as well as an ECG. A "steady state" was usually reached after about five minutes. The heart rate used for each respective work load was the mean of the stethoscope and the ECG recording if the values were within four beats of each other. If not, the highest value was used. The results of this study are included in Table IX.

TABLE IX

MAXIMAL OXYGEN UPTAKE
(ASTRAND - CAUCASIAN TRUCK DRIVERS)

Age Group	N	MVO_2 (ml/kg/min.)
50 - 54	44	33.9 $\pm$ .8*
55 - 59	23	30.9 $\pm$ .9
60 - 64	5	31.9 $\pm$ 2.0

*Mean $\pm$ standard deviation

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[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

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Grimby and Saltin (43) studied 33 very active males 42 - 68 years of age who were all still competing in cross-country running. Exercise tests on a bicycle ergometer on two submaximal loads (600 and 900 kpm/min.) and one maximal load were carried out on two different days. If there was no "levelling off" and the difference was too wide between the two determinations of the maximal oxygen intake (>.2 liters/min.), a third day was used. Expired air was collected in Douglas bags and the volume masured in a spirometer or dry gasometer. Gas samples were analysed with Scholander or modified Haldane apparatus. An ECG was used for heart rate determinations. The maximal oxygen uptakes for these older athletes is given in Table X.

TABLE X

MAXIMAL OXYGEN UPTAKE
(GRIMBY - ACTIVE CAUCASIANS)

Age Group	N	MVO_2 (ml/kg/min.)
40 - 49	14	57.0*
50 - 59	15	53.0
60 - 69	4	43.0

*Standard deviation was not reported.

An additional comparable study by Saltin and Grimby (67) utilized identical methods in testing sedentary older men who were former ahtletes. The results of this experiment are revealed in Table XI.

The maximal oxygen uptake of over 500 Texas Air Force personnel

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was studied by Balke and Ware (15). Subjects were allowed to practice on a treadmill and then were tested on gradually increasing elevations. Determinations of the respiratory gas exchange were made at regular intervals. Using the measurements of the gas exchange during test work the average metabolic requirements for the gradually increased work were superimposed on a graph as oxygen consumption per kilogram body weight per minute in order to demonstrate the correlation between the test duration and the physiologic demands of the corresponding loads. The techniques used to calculate the maximal oxygen consumption were not fully reported. Balke's results appear in Table XII.

TABLE XI

MAXIMAL OXYGEN UPTAKE
(SALTIN - OLDER SEDENTARY CAUCASIANS)

Age Groups	N	MVO_2 (ml/kg/min.)
40 - 49	10	44.0*
50 - 59	14	38.0
60 - 69	5	37.0

*Standard deviation was not reported.

A further interesting aspect of Balke's study involves an arbitrary rating of work capacity based on his results, physiological considerations, and observation of men at various stages of physical conditioning. His rating scale is revealed in Table XIII.

Saltin et al. (68) used 42 sedentary subjects between the ages of 34 and 50 (mean age was 40.5 years) in a study of maximal oxygen uptake. Exercise testing was performed on a Krogh bicycle ergometer

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[illegible]		[illegible]
[illegible]		[illegible]
[illegible]		[illegible]
[illegible]		[illegible]

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[illegible]

[illegible]

TABLE XII

MAXIMAL OXYGEN UPTAKE
(BALKE - U.S. AIR FORCE CAUCASIANS)

Group	Age*	N	MVO_2 (ml/kg/min.)
Officers	25 - 60	530	38.0
Non-commissioned Officers			37.5
Airmen			36.7
Civilian Personnel			36.0
Mean			37.0

*The mean age was not reported.

TABLE XIII

MAXIMAL OXYGEN UPTAKE
(BALKE - U.S. AIR FORCE CAUCASIANS)

Rating of Work Capacity	MVO_2 (ml/kg/min.)
Inferior	0 - 25
Very Poor	25 - 30
Poor	30 - 35
Fair	35 - 40
Good	40 - 45
Very Good	45 - 50
Excellent	50 - 55
Superior	55+

[illegible]

with a pedal frequency of 50 rpm for submaximal exercise and around 60 rpm during maximal exerciase. Ther tests were conducted on two different days, usually the 300, 900 kpm/min. and the lowest maximal loads were performed the first day, and on the second day 600 and 1200 kpm/min. loads as well as the highest maximal loads were performed. The subjects worked for six to seven minutes on 300, 600 and 900 kpm/min. Oxygen uptake was determined by the collection of expired air in Douglas bags. The volume of gas was measured in a spirometer and gas analysis was performed on a modified Haldane apparatus. The heart rate response (monitored on an ECG) during submaximal exercise was used for selection of the first maximal work load. If a subject could work longer than five minutes at this load, it was increased for the second maximal load. If the difference in maximal oxygen uptake was more than three percent, a third maximal work load was performed so that a levelling off could be used as a criterion for maximality in all subjects. The values reported in Table XIV are the before training session values.

TABLE XIV

MAXIMAL OXYGEN UPTAKE
(SALTIN - SEDENTARY CAUCASIANS)

Age Groups	N	MVO_2 (ml/kg/min.)
34 - 50	42	37.5 ± .89*
Mean = 40.5		

*Mean ± standard deviation

Saltin and Astrand (66) collected maximal oxygen uptake data on

[illegible]

95 males belonging to Swedish National Teams. Work was performed on both a treadmill and bicycle ergometer and maximal oxygen uptake was determined by the Douglas bag and Haldane techniques. Heart rate was determined from ECG tracings. The value reported in Table XV is the mean value of the top twenty athletes in the group who were participants in cross-country skiing, orienteering and running. The range of values was 70.9 ml/kg/min. to 85.1 ml/kg/min.

TABLE XV

MAXIMAL OXYGEN UPTAKE
(SALTIN - SWEDISH ATHLETES)

Age Group	N	MVO_2 (ml/kg/min.)
20 - 29	20	78.7*

*Standard deviation was not reported.

Eight male Eskimos living on Baffin Island were the subjects in a maximal oxygen uptake study conducted by Andersen and Hart (5). The mean age of the subjects was 23 years (range 19 - 27 years). All of the subjects were active hunters. Maximal oxygen uptake was measured on a modified bicycle ergometer. Subjects were seated in a comfortable chair, in front of which was mounted an ergometer wheel with variable resistance. The pedalling rate was kept constant between 50 - 60 rpm. Three submaximal work loads were used. Subjects pedalled 45 minutes at these loads, the respiratory and circulatory measurements being taken during the last fifteen minutes of the exercise period. The subjects attempted to reach their maximal level by performing an exhaustive run (bicycling as fast as they could against

a heavy constant resistance for two minutes after an initial five to ten minute warming up period). Measurements were taken during the last half minute. The open circuit system was used for the respiratory measurements. Expired air was collected in Douglas bags and measured by emptying through a dry gas meter. Aliquot samples were analyzed by a Scholander analyzer for carbon dioxide and oxygen. Heart rate was measured from ECG recordings. The maximal oxygen intake of the Eskimos is given in Table XVI.

TABLE XVI

MAXIMAL OXYGEN UPTAKE
(ANDERSEN - ESKIMOS)

Age Group	N	MVO_2 (ml/kg/min.)
20 - 29	8	44.0 ± 5.1*

*Mean ± standard deviation

A further study by Andersen et al. (4) on eleven healthy Arctic Indians was conducted in 1960. The subjects were living at Old Crow in the Yukon. A mechanical braking bicycle ergometer of the von Dobeln type was used for the testing. The collection and analysis of the expired gas was carried out as in the study on the Eskimos just cited. Workloads of 300, 600 and 900 kpm/min. were applied. The subjects exercised three to four minutes before the gas sampling and heart rate counting (stethoscope) started. The maximal oxygen uptake was estimated at a heart rate of 180 beats per minute, and appears in Table XVII.

Hermansen and Andersen (48) studied 26 young men including

14 top athletes and 12 non-athletes who were recreationally active but not in endurance type activities for maximal oxygen uptake. A mechanical type braking bicycle ergometer was used, with a pedalling rate kept constant at 80 rpm. Two or three submaximal work loads were used with measurement being taken during the last minutes of the exercise period. The subjects attempted to reach their maximal level by performing one or two exhausting runs. Measurements were taken during the last half minute using Douglas bags and Scholander gas analysis equipment. Heart rates were measured with an ECG and the results are given in Table XVIII.

TABLE XVII

MAXIMAL OXYGEN UPTAKE
(ANDERSEN - ARCTIC INDIANS)

Age Group	N	MVO_2 (ml/kg/min.)
30 - 39	11	49.1 ± 4.8*

*Mean ± standard deviation. The range was 40.0 to 62.0 ml/kg/min.

TABLE XVIII

MAXIMAL OXYGEN UPTAKE
(HERMANSEN - CAUCASIAN ATHLETES AND STUDENTS)

Group	Age	N	MVO_2 (ml/kg/min.)
Athletes	20 - 29	14	71.8 ± 6.8*
Students	20 - 29	12	44.0 ± 3.9

*Mean ± standard deviation

[illegible]

[illegible]

[illegible]		[illegible]
[illegible]		[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]			[illegible]

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Eighty-six healthy middle aged men (84 Caucasians, one Oriental and one Negroe) acted as subjects for a study conducted by McDonough et al. (57) in 1970. Work was perfromed on a treadmill, and expired air samples were collected at one minute intervals in evacuated neoprene bags. Volumes were measured in a calibrated gasometer and corrected to standard temperature and barometric pressure. Oxygen and carbon dioxide concentrations were measured by the Scholander technique. The final minute of gas collection during which maximal exercise tolerance and highest oxygen intake were reached, was used for maximum oxygen consumption; whereas one to three samples immediately preceding at submaximal loads defined the approach to the maximal level. Heart rate was measured with an ECG and the results of maximal oxygen uptake appear in Table XIX.

TABLE XIX

MAXIMAL OXYGEN UPTAKE
(McDONOUGH - MIDDLE AGED CAUCASIANS)

Age Group	N	MVO_2 (ml/kg/min.)
40 - 44	10	40.5 ± 4.7*
45 - 49	24	38.4 ± 5.3
50 - 54	20	37.5 ± 5.3
55 - 59	19	36.2 ± 5.7
60 - 64	9	32.6 ± 4.7
65 - 69	3	27.7 ± 4.2

*Mean ± standard deviation

In a commentary, Shephard (69) presents normative data from

[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

various groups throughout the world which have been studied for maximal oxygen uptake. Unfortunately, no information regarding age of the subjects or test methodology is presented. However, for general comparative purposes, Table XX presents Shephard's data.

Andersen (3) studied native Pascuans living on Easter Island and reported information on their maximal oxygen uptake. Unfortunately, he did not report information on the number of subjects used nor on methodology. It could be assumed that he used the same method as reported in his other study (cited 4). The data was presented in graphical form, and thus the results presented in Table XXI are extrapolations from this graph.

TABLE XXI

MAXIMAL OXYGEN UPTAKE
(ANDERSEN - PASCUANS ON EASTER ISLAND)

Age Group	MVO_2 (ml/kg/min.)
20 - 29	42.0
30 - 39	42.5
40 - 49	38.0
50 - 59	32.0
over 60	25.0

In a Canadian study, Cumming (cited 36) reported maximal oxygen uptake data on Winnipeg men working in both industry and office. Cumming failed to report information on the measurement techniques used for obtaining the data appearing in Table XXII.

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

TABLE XX

MAXIMAL OXYGEN UPTAKE
(SHEPHARD - VARIOUS CAUCASIAN GROUPS)

Group	MVO_2 (ml/kg/min.)
Swedish Soldiers	63.6
British Servicemen	43.7 - 48.7*
U.S. Servicemen	36.5
German Soldiers	32.5
Swedish Industrial Workers	52.9
Holland Industrial Workers	43.7
Australian Industrial Workers	44.2
Scandinavian Students	53.4
Canadian Students	40.4
U.S. Students	48.7

*Results from two different series of experiments.

Cumming (cited 36) arbitrarily suggests that an oxygen intake of 40 ml/kg/min. could be set as a cut-off point between fit and the unfit individuals up to the age of 60 years. This compares favorably with the rating scale created by Balke (cited 15).

TABLE XXII

MAXIMAL OXYGEN UPTAKE
(CUMMING - WINNIPEG CAUCASIANS)

Age Group	Industry Workers	Office Workers
20 - 29	44	44
30 - 39	38	38
40 - 49	38	33
50 - 59	36	31

A recent comprehensive investigation of the maximal oxygen uptake of selected Japanese populations was conducted by Ikai et al. (49) in 1970. Twenty-one Ainu men and 96 other Japanese men were screened for disease and classified by occupation. Most of the subjects were relatively sedentary but did do considerable walking on the job. None of the groups was overweight. The exercise tests were conducted on a Monark bicycle ergometer at least two hours after the last meal and in comfortable environmental conditions. The maximum work capacity involved the use of progressive work loads designed to exhaust the subjects within ten minutes. Pedal frequency was 60 rpm. The initial work load was adjusted to 720 kpm/min. (.5kp) each minute until the subject was exhausted or could not maintain the pedal frequency. Expired gas samples were collected in Douglas bags during each of the last

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible]

three minutes before the termination of exercise and analyzed for oxygen and carbon dioxide by using the micro-Scholander gas analyzer. Gas volume was measured with a dry gas meter and heart rate was determined from a bipolar ECG chest lead. Ikai's results appear in Table XXIII.

Cumming (36) reviewed various studies utilizing the Sjostrand PWC_{170} test as the method of reporting on cardio-respiratory fitness. This work test is described by Sjostrand (73) and is essentially a submaximal test conducted on a bicycle ergometer. This test is not a test of maximal oxygen consumption although it may correlate highly with such a criterion. PWC_{170} simply means the amount of work that can be done (in kpm/min.) by an individual at a steady heart rate of 170 beats per minute. The results from the literature presented by Cumming appear in Table XXIV.

Steadward and Donovan (58) studied 27 middle aged men who were members of a joggers club but otherwise inactive on the Sjostrand PWC_{170} test. The subjects were tested three times during a six month jogging period. The results of the third testing session were presented in percentile form and are given in Table XXV on page 34.

Kolias et al. (52) studied maximal oxygen uptake on six trained runners and six non-athletic personnel from Pennsylvania State University, together with eight Peruvian Indians native to a base altitude of 4000 meters. All tests were conducted at this altitude. For purposes of the present study, only data on the native Peruvian Indians will be presented. A maximal work capacity test designed to exhaust a man within ten minutes was conducted on a Monark bicycle ergometer. Using a pedalling frequency of 60 rpm, the work load was set at three kiloponds (1080 kpm/min.) for the

TABLE XXIII

MAXIMAL OXYGEN UPTAKE
(IKAI - JAPANESE)

Age Group	Ainu	Farmers	Policemen	Fishermen	Fish Factory Workers	Students at Hokkaido	Students at Nonshu
20 - 29	42.0 ± 6.3 MA* = 27.4 N = 21	42.5 ± 8.6 MA = 28.9 N = 25	41.8 ± 6.9 MA = 26.7 N = 26		40.9 ± 4.0 MA = 29.3 N = 8	41.8 ± 4.4 MA = 22.1 N = 14	45.2 ± 5.3** MA = 22.7 N = 10
40 - 49				38.6 ± 5.2 MA = 43.7 N = 13			

*MA = mean age
**Mean ± standard deviation

TABLE XXIV

PHYSICAL WORKING CAPACITY$_{170}$

(CUMMING - REVIEW OF CAUCASIAN STUDIES)

Group	PWC_{170}
Winnipeg Medical Students*	964
Stockholm Medical Students	1111
Winnipeg Managers	1144
Stockholm Managers	1038
Winnipeg Factory Workers	1094
Stockholm Physicians	1053
Sweden - Army Conscripts	1058
Sweden - Middle Distance Runners	1551
Winnipeg - Water Polo Players	1310
Sweden - Weight Lifters	1177

*Age range of all studies reported is 20 - 40 years.

TABLE XXV

PHYSICAL WORKING CAPACITY$_{170}$ NORMS
(STEADWARD - ALBERTA JOGGERS CLUB)

Percentile	Age Groups 30 - 39	40 - 49	50+
100	1799.5	1599.5	1499.5
95	1734.5	1554.5	1487.0
90	1569.5	1509.5	1474.5
85	1504.5	1464.5	1462.0
80	1469.5	1419.5	1449.5
75	1437.0	1374.5	1437.0
70	1404.5	1314.5	1424.5
65	1372.0	1284.5	1412.0
60	1339.5	1239.5	1199.5
55	1307.0	1097.5	1174.5
50	1249.5	1074.5	1149.5
45	1184.5	1052.0	1124.5
40	1119.5	1029.5	899.5
35	1074.5	1007.0	874.5
30	1044.5	989.5	849.5
25	1012.0	974.5	824.5
20	979.5	959.5	799.5
15	947.0	944.5	774.5
10	914.5	944.5	749.5
5	864.5	914.5	724.5
0	799.5	899.5	699.5

first two minutes and was increased .5 kp (180 kpm.) each minute thereafter until the subject could no longer maintain the pedalling frequency. Each subject breathed through a low-resistance Collins triple-J valve. Expired air was collected in Douglas bags and analysed for oxygen and carbon dioxide with a Beckman E-2 analyser. The mean value for maximal oxygen uptake for the Peruvian Indians (mean age not reported) was 51.8 ml/kg/min. (standard deviation 3.4).

Shephard (72) has presented a good review of maximal oxygen uptake normative data from the world literature which includes 7500 male subjects. He also presents some excellent points in reference to problems of interpretation of data originating from various laboratories around the world. It is interesting to note that Shephard has applied the following corrections to the data before including them in his article (72:667, 668):

> 1. Many authors group subjects by decades and report a mean age for the group. In such instances, data has been corrected to the average for the decade by assuming a decline in maximal oxygen consumption of .02 liters per minute per year of adult life.
>
> 2. All bicycle ergometer test results have been increased by seven percent.
>
> 3. Values obtained by use of the Astrand Rhyming nomogram were increased by eight percent.
>
> 4. Values reported only as PWC_{170} (physical working capacity at a heart rate of 170 beats per minute) were transformed by the use of the nomogram and corrected as above.

The summarized data presented by Shephard appears in Table XXVI on page 36.

The Research Committee of the Canadian Association of Health, Physical Education and Recreation with support from the Department of National Health and Welfare, has conducted a normative study of the

TABLE XXVI

MAXIMAL OXYGEN UPTAKE
(SHEPHARD - REVIEW OF WORLD VALUES)

National Grouping	Age Groups 20 - 30	30 - 40	40 - 50	50 - 60
Canada (untrained)	48.0* (35.7-57.7) N = 88	40.8 (35.4-43.5) N = 24	39.1 (36.5-43.0) N = 65	39.5 (36.2-42.7) N = 16
Canada (active and athletic)	55.1 (47.3-60.2) N = 38			
United States (untrained)	37.6 (29.5-55.0) N = 1005	36.2 (30.0-39.2) N = 333	35.7 (35.3-39.2) N = 112	35.7 (30.5-37.6) N = 11
United States (active and athletic)	51.5 (48.3-54.6) N = 152		51.3 (51.3) N = 8	
Scandinavia (untrained)	59.1 (46.4-63.6) N = 511	43.7 (42.2-46.3) N = 57	44.6 (41.9-44.6) N = 377	34.5 (31.3-37.1) N = 176
Scandinavia (active and athletic)	58.5 (52.4-63.0) N = 123	53.6 (50.7-55.0) N = 24		47.1 (47.1) N = 6
Other Countries (untrained)	44.9 (32.5-48.6) N = 767	40.1 (36.4-46.4) N = 370	35.1 (33.0-41.1) N = 136	30.4 (25.5-33.6) N = 203
Other Countries (active and athletic)	47.2 (45.1-47.7) N = 170	59.1 (59.1) N = 127		
All Countries (untrained)	45.0 (29.5-63.6) N = 2371	38.7 (30.0-46.4) N = 784	36.3 (33.0-44.6) N = 690	32.7 (25.5-42.7) N = 406
All Countries (active and athletic)	69.1 (60.6-80.2) N = 50			51.3 (50.3-52.3) N = 138

*Mean for all authors and range of means for individual authors.

physical fitness of 451 Canadian males and females between the ages of 18 and 44 years (cited 31). Physical working capacity at a heart rate of 170 beats per minute was established for all subjects using a modified Monark bicycle ergometer. Subjects pedalled for a total of twelve minutes, with the loads being increased at the end of the fourth, and eighth minutes. Heart rates were monitored by an electrocardiogram. The normative tables for physical working capacity for Canadian men are presented in percentile form and appear in Table XXVII in page 38.

SKINFOLDS AND BODY FAT

The establishment of the amount of fat in the human body can provide information on nutritional status as well as reflect physical activity level and is thus important in describing the anthropometric characteristics of subjects tested on physical fitness parameters in addition to reporting on the traditional height and gross body weight.

Researchers have been searching for some time for a technique which will accurately estimate the percentage of the body weight which is fat (17, 19, 25, 30). Since the density of fat is low compared to other tissues, changes in fat content alter the specific gravity of the body (17, 25, 16, 28). From these changes in specific gravity, researchers have developed formulas which estimate the percentage of body weight which is fat.

Keys and Brozek (51) have done extensive review and development work with these estimation formulas for body fat. The latest formula of Brozek et al. (cited 28) assumes that there have been no large recent fluctuations in body weight and is as follows:

TABLE XXVII

PHYSICAL WORKING CAPACITY$_{170}$
(CAHPER - CANADIAN NORMS)

Percentile	Age Group 18 - 19		20 - 24		25 - 34		35 - 44	
	A	B	A	B	A	B	A*	B*
100	1765	23.00	1791	22.00	2132	24.00	1808	22.00
95	1381	19.18	1464	20.15	1513	18.59	1585	19.93
90	1273	18.57	1363	18.60	1393	17.74	1394	18.35
85	1218	18.21	1320	17.64	1295	16.82	1315	17.07
80	1144	17.08	1238	16.49	1241	16.40	1250	16.65
75	1101	16.13	1192	16.12	1199	14.99	1197	15.45
70	1090	15.94	1156	15.69	1135	14.49	1141	14.69
65	1064	15.35	1123	15.19	1083	13.97	1080	14.03
60	1050	15.24	1054	14.64	1065	13.62	1060	13.62
55	1012	14.84	1003	14.28	1018	13.40	1047	13.34
50	1005	14.52	953	13.91	947	13.14	1028	13.01
45	982	14.37	917	13.67	930	12.66	1000	12.88
40	956	13.80	905	12.93	904	12.17	988	12.42
35	933	13.23	862	12.73	893	11.71	949	12.18
30	886	12.95	849	12.27	863	11.42	923	11.92
25	870	12.43	825	11.60	848	11.08	887	11.29
20	840	11.97	808	11.24	801	10.57	857	11.04
15	805	11.66	781	10.62	778	9.98	834	10.69
10	778	10.59	735	10.00	761	9.36	790	9.81
5	598	9.05	635	9.69	714	8.70	690	8.52

*A = PWC$_{170}$ B = PWC$_{170}$/kg.

Percent Body Fat = 100(4.570/specific gravity - 4.142)

This formula will be used for calculation of body fat in the present study.

There are, unfortunately, almost as many formulas as there are investigators for the calculation of specific gravity from skinfold measurements. The multiple regression equations adapted from Brozek and Keys (cited 27) will be used in this study for the calculation of specific gravity. These formulas were presented in Chapter I.

The nomogram presented by Consolazio et al. (34:306) will be used to determine relative body weight for substitution in the regression equation for men aged 45 - 60 years.

Several studies (20, 28, 75) have compared the results obtained from the various formulas for the prediction of body fat and have found the estimates are consistently different from one another. Unfortunately this will limit the direct comparability of data obtained using different methods and formulas.

It is fortunate that most of the recent studies utilizing skinfold measurements have adhered to reasonably well-standardized procedures with the exception of the sites being measured. Brozek (22) summarizes these procedures as follows:

1. The calipers should exert a standard pressure of 10 grams per square millimeter at all openings and have a contact surface area between 20 and 40 square millimeters (22, 58, 81).

2. The skin should be lifted by grasping firmly the fold between the thumb and forefinger.

3. At a given site, the width of the skin should be minimal, still yielding a well-defined fold.

4. The calipers should be placed about one centimeter from where the skinfold is lifted.

5. Sites should be clearly defined and carefully identified prior to measuring skinfolds in a given individual.

[illegible]

6. The investigator should be well-practiced.

7. All measurements should be made on the same side of the body. (Damon (38) recommends lifting the skinfold between two hands and measured on the left side, however the need for an assistant as well as the existence of much data from the right side of the body outweighs the advantage of modifying current practice).

8. The caliper scale should allow readings to be taken to the nearest 0.1 millimeter (40).

These recommendations will be followed in the present investigation of Indian males using a Harpenden Skinfold Caliper as described by Tanner (81).

In reviewing the literature of skinfold measurements on various groups, studies adhering as closely as possible to the above recommendations will be reported. Therefore within the limitations of the error between investigators, and differences in jaw pressure (mentioned where applicable), the data will be reasonably valid for comparative purposes.

Slome et al. (76) made skinfold measurements using a Harpenden skinfold caliper on Zulu adults living in Durban, South Africa. A triceps measurement was made on the right arm three times. The mean value of these three measurements was taken to be the true value and the results by age group appear in Table XXVIII.

TABLE XXVIII

TRICEPS SKINFOLD
(SLOME - SOUTH AFRICAN ZULUS)

Age Group	Triceps Skinfold (mm.)
20 - 29*	8.56
30 - 39	8.38
40 - 49	9.00
over 50	11.55

*Neither the number of subjects in each age group nor the mean age was reported.

Steinkamp et al. (78) reported skinfold measurements of 2301 healthy volunteer subjects. Lange skinfold calipers were used having a standard pressure of 10 $gm/mm.^2$ and all measurements were made on the right side of the body. The subjects were Caucasian males and Negroe males. The tabulated results of this study are given in Table XXIX.

TABLE XXIX

SKINFOLDS
(STEINKAMP - CAUCASIANS AND NEGROES)

Skinfold	Caucasian Males 25 - 34 years N = 478	Caucasian Males 35 - 44 years N = 416	Negroe Males 25 - 44 years N = 342
Arm	11 ± 5.2*	12.0 ± 4.1	10.0 ± 4.6
Scapula	12 ± 4.7	13.0 ± 4.6	14.0 ± 5.8
Abdomen	16 ± 9.6	18.0 ± 10.0	14.0 ± 9.1

*Mean ± standard deviation (mm.)

In the above study, the arm skinfold was taken with the subject standing and the arm flexed at 90 degrees. The scapula measurement was made at the inferior angle of the scapula at an angle of about 45 degrees to the horizontal while the abdominal measurement was made with the subject supine, knees bent, while the skinfold was lifted one inch to the right of midline, halfway between the symphysis pubis and umbilicus, parallel to the mid-abdominal line.

Brozek et al. (29) conducted a study of 1708 men employed as switchmen or clerks with railroads in the Northwestern United States. Skinfolds were taken using a modified Best (18) caliper at two sites;

upper arm (triceps) and right subscapular. The caliper pressure was constant at the standard 10 gm/mm.[2] The median combined skinfold (triceps and subscapular) appear in Table XXX.

TABLE XXX

SKINFOLD
(BROZEK - U.S. RAILROAD WORKERS)

Age Group	Combined Skinfold (mm.)
40 - 49	31.8
50 - 59	32.5

Approximately fifty percent of Brozek's subjects had a triceps only skinfold between 11 and 14 mm., while the subscapular skinfold was between 17 and 20 mm. for a similar fifty percent of the subjects.

Elsner (41) presents a comprehensive review of skinfold studies conducted on primitive peoples native to cold climates. All results presented in Table XXXI were obtained by a Best Caliper and the sites measured were according to Skerlj et al. (74). The measurements are, therefore, fairly suitable for comparative purposes.

As part of nutritional surveys carried out among the Papuans of Western New Guinea in 1957, Jansen (50) reported skinfold measurements on four groups differing in basic nutritional habits and medical status. The four groups included: (1) four villages on Biak Island, (2) the village of Nubuai, (3) the headquarters of an oil company at Sarong, and (4) the central mountain region called Mappia. The first two groups live under unfavorable conditions as do the Mappian villagers. The Papuan workers at Sarong are well cared for medically and have an

[illegible]

TABLE XXXI

SKINFOLDS
(ELLSNER - PRIMITIVE PEOPLES IN COLD CLIMATES)

Average Age (years)	Group	N	Chest	Upper Arm	Back	Abdomen
30	Urban Caucasian Controls	11	7*	10	11	11
21	Australian Aborigines	9	6	8	3	11
32	Alaculuf Indians (Chile)	8	4	7	10	9
34	Norwegian Lapps	27	5	7	9	9
19	Australian Aborigines	8	4	6	10	7
26	Quecha	9	5	5	8	6
29	Arctic Indians	9	4	5	7	6
25	Canadian Eskimos	16	4	6	7	5
-	Alaskan Eskimos	-	3	4	7	6
30	Kalahari Bushmen	10	3	4	6	4

*Average skinfold thicknesses in mm.

adequate diet. The data presented by Jansen represent mean skinfolds taken with a slide caliper having a face surface of 40 mm.^{2} and a constant pressure of 15 gm/mm.^{2} Unfortunately, this higher than standard pressure limits comparison as the skinfolds would be slightly lower than had calipers exerting the standard pressure of 10 gm/mm.^{2} been used. The skinfolds reported in Table XXXII were taken (1) at the back of the right upper arm (triceps) halfway between the tip of the acromial process and the tip of the elbow with the arm hanging down, (2) below the tip of the right scapula and (3) above the right breast.

TABLE XXXII

SKINFOLDS
(JANSEN - PAPUANS)

Group	N	Triceps	Scapula	Chest
Biak and Nubuai				
20 - 29	9	4.4	6.8	5.1
30 - 39	16	4.7	6.8	5.4
40 - 49	6	4.0	6.9	4.1
Sarong				
20 - 29	6	5.2	7.8	4.5
30 - 39	12	4.0	7.0	4.1
Mappia				
20 - 29	9	3.3	6.3	3.4
30 - 39	11	2.9	6.0	3.1

Chen et al. (32) studied 31 young men between the ages of 17 and 29 and 22 middle-aged men between 30 and 54 years of age on various physiological and body composition measures. Most of the subjects worked

in the Taiwan Medical College but no report was made on activity level or physical fitness. The skinfolds were measured according to the procedure of Skerjl et al. (74) using a skinfold caliper exerting a variable pressure of 5.4 gm/mm.^{2} at maximal opening. For obvious reasons, caution is advised in using the data for comparative purposes as the values will be higher than had the standard caliper pressure been used. Chen's data appears in Table XXXIII.

TABLE XXXIII

SKINFOLDS
(CHEN - CHINESE)

Group	N	Chest	Abdomen	Subscapular	Triceps
Young men (mean age = 23)	31	4.79 ± 3.37	6.56 ± 3.76	8.02 ± 3.91	6.31 ± 2.03*
Middle aged Men (mean age not reported)	22	10.71 ± 7.76	15.77 ± 11.49	13.69 ± 8.05	12.55 ± 9.10

*Mean ± standard deviation

Chen also reported on percent body fat of his subjects. Densitometry was performed as described by Allen et al. (2) and body fat was calculated from specific gravity by the Rathburn and Pace formula (64). The values obtained for these measures appear in Table XXXIV.

TABLE XXXIV

PERCENT FAT (CHEN - CHINESE)

Group	N	% Body Fat
Young men	31	9.94 ± 5.09
Middle aged men	22	18.7 ± 7.11

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Norris et al. (61) in a study of 143 sedentary males between 20 - 99 years determined percent body fat using the 1953 formula of Brozek and Keys (26). In addition, two other formulas were used; that of Siri and Behnke (1957) and their own formula modified from the Brozek and Keys (1953) formula. The results obtained on the same subjects differed indicating caution in interpretation and comparison. The helium dilution technique was used for the determination of specific gravity. The results presented in Table XXXV are those obtained by use of the Brozek and Keys (1953) formula.

TABLE XXXV

PERCENT FAT
(NORRIS - SEDENTARY CAUCASIANS)

Age Group	N	% Body Fat
20 - 29	4	29.8 ± 5.94*
30 - 39	23	27.9 ± 8.12
40 - 49	35	28.9 ± 6.86
50 - 59	30	30.2 ± 7.87
60 - 69	26	31.1 ± 8.25
70 - 79	21	29.8 ± 6.87

*Mean ± standard deviation

In Ikai's study (cited 49), body fat was calculated from skinfold data according to the procedure of Allen et al. (2) The percent body fat of the various groups in this study appear in Table XXXVI.

Grimby (cited 43) in his study of 33 older Swedish athletes

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[illegible]

[illegible]			[illegible]
[illegible]			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]
[illegible]			[illegible]
[illegible]	[illegible]		[illegible]
[illegible]			[illegible]

[illegible]

TABLE XXXVI

PERCENT FAT
(IKAI - JAPANESE)

Japanese Group	Age Range	% Body Fat
Ainu	20 - 29	9.6 ± 3.5*
Farmers	20 - 29	13.8 ± 5.9
Policemen	20 - 29	13.0 ± 4.5
Fishermen	40 - 49	14.1 ± 5.5
Fish Factory Workers	40 - 49	11.2 ± 4.6
Hokkaido Students	20 - 29	11.4 ± 4.8
Honshu Students	20 - 29	10.5 ± 6.0

*Mean ± standard deviation

aged 42 - 68 years, reprted a mean subscapular skinfold of 9.6 mm. and a mean percent body fat of 11.8 percent. No mention is made of how the skinfold measurements were taken. The fat free body weight (mean of 60 kg.) was determined from anthropometric data (no further explanation) and the percentage fat was calculated by dividing the difference in mean gross body weight and fat free weight by the gross body weight times 100. This is a unique method which may limit the comparability of this data.

The study of Eskimos by Andersen (cited 5) reported lean body mass data as well as gross body weight of the subjects. Lean body mass was calculated from skinfold measurements using the formula of Allen et al. (cited 2) This author calculated percent body fat from the data presented by Andersen and arrived at a mean figure for the eight Eskimos of 13.16 percent.

Brozek and Keys (cited 26) present percent fat data for 273 men predicted from age. The data was calculated from the formula:

$$y = -5.55564 + 0.92836X - 0.006776X^2$$

Where: y = percent body fat
x = age

The average values of percent fat calculated from groups of individuals (N unknown) of average height reported by Brozek and Keys appear in Table XXXVII.

Orpin and Scott (62) studied a normal, small New Zealand population on skinfold measurements and determined percent body fat by the following formula derived by Fletcher (62):

Total body fat = nine site fat fold (mm.) x height^2 (meters) x 0.1

All skinfold measurements were made with a Harpenden skinfold caliper

TABLE XXXVII

PERCENT FAT
(BROZEK - CAUCASIANS)

Age	% Body Fat
20	10.3
25	13.4
30	16.2
35	18.6
40	20.7
45	22.5
50	23.9
55	25.0

exerting the standard pressure of 10 gm/mm.[2] Table XXXVIII summarizes the percent body fat data by age for this population.

TABLE XXXVIII

PERCENT FAT
(ORPIN - NEW ZEALANDERS)

Age	N	% Body Fat
21 - 30	16	11.6 ± 3.3*
31 - 40	20	14.0 ± 4.9

*Mean ± standard deviation

Two hundred and thirty-five male employees of the United States Atomic Energy Commission in Washington were the subjects in a study by Crook et al. (35) designed to investigate the relative merits of four methods of predicting body fat. These methods included (a) radioactive potassium, (b) height-weight measurements, (c) skinfold measurements on the scapula, and (d) skinfold measurements on the triceps. In this study, a Lange skinfold caliper was used. The triceps measurements were obtained by choosing an area midway between the point of the shoulder and the elbow on the posterior aspect of the upper arm. The scapular measurements were obtained by choosing an area overlying the inferior aspect of the scapula. The percent body fat data was determined by the radioactive potassium technique as described by Allen et al. (1)

Crook's data for triceps and subscapular skinfold, and percent fat for the subjects having a mean age of 34 years appear in Table XXXIX.

[illegible]

TABLE XXXIX

SKINFOLDS
(CROOK - U.S. CAUCASIANS)

% Body Fat	Mean Scapular Skinfold (mm)	Mean Triceps Skinfold (mm)
22.17	15.37	10.92

Durnin and Rahaman (39) used 60 males as part of a total sample of 191 in a study of four skinfold measurements as predictors of total body fat. They measured skinfolds with a Harpenden skinfold caliper exerting a constant 10 $gm/mm.^2$ pressure. Measurements were taken on the right side of the body while the subjects sat on a stool. Unfortunately, only the sum of the four skinfolds (biceps, triceps, subscapular, suprailiac) were reported and therefore no mean values for each site are available. Using their own formula based on logarithms, they calculated body density of the 60 males. The regression equation used was:

$$y = 1.1610 - 0.0632X$$

Where: y = body density
X = log of the sum of skinfold thicknesses at four sites

Durnin and Rahaman then substituted into Siri's formula for percent fat which is:

$$\text{Fat (\%)} = (4.95/\text{density} - 4.50) \times 100$$

The resulting mean percent body fat for these 60 British male subjects was 13.5 percent (standard deviation = $\pm$ 5.8).

Pett and Ogilvie (63) conducted an extensive survey of approximately 22,000 Canadians in order to establish norms for height, weight and skinfolds. The skinfold site chosen was the

back (triceps) of the upper arm, and it was measured using a caliper designed and manufactured in the Laboratory of Physiological Hygiene at the University of Minnesota. This device exerted a constant pressure of 10 gm/mm.^{2} and had a surface area of 40 mm.^{2} The triceps mean vlue for males of varying ages is presented in Table XL.

TABLE XL

TRICEPS SKINFOLD
(PETT - CANADIAN CAUCASIANS)

Age Group	Average Triceps Skinfold (mm)
20 - 24*	6.3
25 - 29	7.0
30 - 34	8.2
35 - 44	7.7
45 - 54	7.5
55 - 64	6.9
over 65	5.6

*Number of subjects in each age group unknown.

Newman (60) presents anthropometric data on 2017 white males, and 361 Negroe males. The mean ages of these groups was 20.7 and 20.8 years respectively. The technique of skinfold measurements was not reported, however measurements included triceps, subscapular and abdominal. Percent body fat was calculated using the formula of Brozek and Keys (cited 27). The data presented by Newman appear in Table XLI.

[illegible]

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[illegible]

[illegible]

[illegible]	[illegible]	[illegible]

[illegible]

TABLE XLI

SKINFOLDS
(NEWMAN - CAUCASIANS AND NEGROES)

Group	N	Mean Age	Triceps	Skinfold (mm) Subscapular	Abdomen
Whites	2017	20.7	11.4 ± 5.4*	13.6 ± 6.0	14.6 ± 7.9
Negroes	361	20.8	8.2 ± 4.0	12.2 ± 4.3	11.7 ± 5.7

*Mean ± standard deviation

Brozek (23) presents a concise overview of techniques for measuring leaness - fatness in men and includes norms for skinfolds based upon a study of 238 subjects who were healthy members of the Minneapolis Fire Department. Due to the skewness of skinfold data, Brozek presents his data in the form of a frequency distribution. His measurements were made using a standard 10 gm/mm^2 pressure caliper on the triceps and subscapular regions. Interpolation from his distribution revealed the following:

1. The greatest number of subjects (mean age 41.6 years) had triceps skinfolds between 10.0 and 11.4 mm.

2. No subjects had triceps skinfolds below 4.0 mm. or above 23.4 mm.

3. The greatest number of subjects had subscapular skinfolds between 13.5 and 18.4 mm.

4. No subjects had subscapular measurements below 6.0 mm. or above 48.4 mm.

5. The 50th percentile for triceps skinfolds was 12.5 mm. while the 50th percentile for subscapular skinfolds was 16.5 mm.

In their often quoted study, Brozek and Keys (cited 27) used 133 male college students (mean age 20.3 years) and 122 male middle aged men (mean age 49.0 years) for a determination of normative

skinfold data as well as the derivation of a regression equation for predicting body fat. Skinfold measurements were made with a caliper having an initial opening tension of 35.4 gm/mm.^{2} The area of the contact points was 3 mm.^{2} There was only a small increase in pressure when the jaws were opened more widely. Over the range of skinfold thicknesses encountered in their study, the effective tension of the calipers increased linearly at 7.8 gm/cm. jaw opening. The authors feel that this variation did not affect appreciably the skinfold values. Included in the skinfold measurements were: (a) abdomen, to the right of the navel, (b) chest, above and to the right of the nipple, (c) back, below the right scapula, (d) arm, on the back, halfway down the upper arm. No mention is made of the exact formula used for the calculation of percent body fat. On the basis of their sample, the best prediction equations for the calculation of specific gravity are:

For young men - $y = 1.1017 - 0.000282X_1 - 0.000736X_2 - 0.000883X_4$

Where: y = specific gravity
X_1 = abdomen skinfold (mm.)
X_2 = chest skinfold (mm.)
X_4 = triceps skinfold (mm.)

For older men -

$$y = 1.0967 - 0.000393X_2 - 0.000315X_3 - 0.000598X_4 - 0.000170X_6$$

Where: y = specific gravity
X_2 = chest skinfold (mm.)
X_3 = subscapular skinfold (mm.)
X_4 = triceps skinfold (mm.)
X_6 = relative body weight (actual weight as a percentage of standard weight based on the 1912 Medico-Actuarial Standards).

The normative data presented by Brozek and Keys as a result of this study is presented in Table XLII.

TABLE XLII

SKINFOLDS AND BODY FAT
(BROZEK - CAUCASIANS)

Group	Mean Age	N	Abdomen	Chest	Subscapular	Thighs	Body Fat
Young College Students	20.3	133	18.2 ± 8.4	15.9 ± 7.4	14.31 ± 5.8	10.9 ± 4.6 *	10.93%
Middle Age Men	49.0	122	25.5 ± 7.8	24.5 ± 7.8	19.9 ± 7.1	14.4 ± 4.2	21.3%

*Mean ± standard deviation (mm.)

The Canadian study of males and females (cited 31) also include normative data on skinfolds measured at three sites common to the present study. These sites include subscapular, triceps and abdominal measures. The skinfolds were measured according to standardized procedures using a Harpenden skinfold caliper. However, the sites were measured on the left side of the body rather than on the right side as in the present study. The variation is assumed to be negligible. The normative data is summarized in Table XLIII, on page 56.

The problem associated with assessing body fat from various anthropometric techniques has not been solved. Damon and Goldman (52) have summed up the situation by stating (52:33):

> The investigator who wishes to learn which measurements to take, or with certain "recommended" measurements in hand, wishes to estimate the percentage of fat among his subjects, can find a dozen formulas, some with standard errors of estimate, but no indication which is best for his purposes. Only part of the uncertainty is attributable to selection of subjects and measuring techniques; the rest arises because the same equations have not been tested on other subjects, nor different equations compared on the same subjects.

TABLE XLIII

SKINFOLDS
(CAHPER - CANADIAN NORMS)

Percentile	Age Group 18 - 19			20 - 24			25 - 34			35 - 44		
	S*	T**	A***	S	T	A	S	T	A	S	T	A
100	32	23	37	32	16	39	43	19	46	42	35	41****
95	11	11	21	17	14	32	23	16	38	25	15	35
90	12	10	17	15	12	28	22	15	33	21	13	31
85	11	9	15	14	12	22	19	13	30	20	13	29
80	10	9	13	13	10	18	17	13	26	19	12	27
75	10	8	12	12	10	17	17	12	25	18	11	25
70	10	8	12	12	9	16	16	11	23	17	11	22
65	9	7	11	11	8	14	14	10	21	16	10	21
60	9	7	10	10	7	13	13	10	20	16	10	19
55	9	7	10	10	7	12	13	9	19	15	9	18
50	8	6	9	10	7	11	12	9	18	14	9	18
45	8	6	8	9	6	10	12	8	17	13	8	17
40	8	6	8	9	6	9	11	8	15	13	8	16
35	8	6	7	9	6	8	11	7	13	13	8	16
30	7	5	7	9	5	8	11	6	12	12	7	14
25	7	5	7	8	5	7	10	6	10	11	7	13
20	7	5	6	8	4	6	9	6	9	11	7	13
15	6	5	6	8	4	6	8	5	8	10	6	11
10	6	4	5	7	4	5	8	5	7	9	6	10
5	6	4	5	7	4	5	7	4	5	8	5	8

*S = Subscapular, **T = Triceps, ***A = Abdomen
****All measurements in millimeters.

VITAL CAPACITY

In addition to values already reported, several other studies previously cited have reported data on the vital capacities of the subjects tested. The data is summarized in Table XLIV.

TABLE XLIV

VITAL CAPACITY
(SUMMARY OF CITED STUDIES)

Group	Reference	N	Age Group	Vital Capacity (liters)
Philedelphia	(10)	-	50 - 59	4.35
		-	over 60	4.35
Stockholm Truck Drivers	(9)	46	50 - 54	4.72
		27	55 - 59	4.59
		8	60 - 64	4.17
Sweden Older Athletes	(43)	14	40 - 49	4.9
		15	50 - 59	5.0
		4	over 60	3.2
Sweden Older Former Athletes	(67)	10	40 - 49	5.0
		14	50 - 59	4.6
		5	over 60	4.3
Chinese	(32)	31	20 - 29	3.96
		22	30 - 54	3.83

Erikson (42) measured the vital capacities of ten Eskimos living in Port Barrow, Alaska using a wet spirometer. The mean age of the men was 19.9 years and the mean vital capacity was 4.5 liters (range 3.5 - 5.6).

Grimby and Soderholm (44) measured various respiratory parameters including vital capacity on 152 men between the ages of 20 - 65 years (mean age 40.0 years) and found that the mean vital

capacity was 4.89 liters.

It appears from the literature that vital capacity declines with age and that the average vital capacity of a healthy individual would be between four and five liters.

STRENGTH

In 1925 Dr. Frederick Rand Rogers standardized strength testing procedures and developed norm tables for their interpretation. The norm tables are based upon sex, weight and age and were developed separately when a belt was used in the leg lift and when it was not used. The former norm table will be used for comparative purposes in this study and is reproduced on page 59.

Unfortunately, the normative strength index tables were developed for the range 18 to 38 years of age. However, norms for men over 38 years of age may be calculated roughly be subtracting twenty points from the 38-year norm for each year over 38 (33:428). In addition, norms for individuals whose weights are above those included in the table can be calculated by adding to the norm for any chosen weight, the pound difference between that weight and the individual's weight times the Weight-Deviation Multiplier supplied on the normative table. These corrections will be applied where indicated to the results of the present study.

In addition to the Strength Index comparisons, the grip strength of the Indian males in this study will be compared to the normative values for Canadian males (cited 31). The Canadian subjects were measured on grip strength using a Stolting grip dynamometer similar to the one used in this study. Each subject was asked to squeeze

Table B.2b

STRENGTH INDEX NORMS FOR MEN (BELT)

Age

Weight	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	Weight
230													3845	3796	3755	3722	3690	3664	3642	3621	3601	230
228													3803	3759	3719	3686	3653	3628	3606	3585	3565	228
226													3771	3723	3682	3619	3617	3592	3570	3549	3529	226
224													3734	3686	3646	3613	3581	3555	3534	3513	3193	224
222													3697	3650	3609	3577	3545	3519	3498	3477	3457	222
220												3706	3660	3613	3573	3541	3509	3483	3462	3441	3421	220
218												3669	3623	3576	3537	3504	3473	3447	3126	3405	3385	218
216												3632	3586	3540	3500	3168	3137	3411	3390	3369	3349	216
214											3650	3595	3549	3503	3464	3432	3401	3375	3354	3333	3313	214
212											3613	3557	3512	3467	3127	3396	3363	3339	3318	3297	3277	212
210										3626	3575	3520	3476	3130	3391	3359	3329	3303	3282	3261	3241	210
208										3588	3533	3483	3439	3393	3255	3323	3292	3267	3246	3225	3205	208
206										3550	3500	3146	3402	3357	3318	3287	3256	3231	3210	3189	3169	206
204									3567	3512	3462	3408	3365	3320	3282	3251	3220	3195	3174	3153	3133	204
202								3580	3529	3474	3425	3371	3328	3284	3245	3214	3184	3159	3138	3117	3097	202
200							3594	3541	3190	3436	3387	3334	3291	3247	3209	3178	3148	3123	3102	3081	3061	200
198						3603	3554	3502	3151	3393	3349	3297	3254	3210	3173	3142	3112	3087	3066	3045	3025	198
196					3596	3562	3514	3162	3413	3360	3312	3260	3217	3174	3136	3105	3076	3051	3030	3009	2989	196
194				3564	3554	3521	3474	3423	3374	3322	3274	3222	3180	3137	3100	3069	3040	3015	2994	2973	2953	194
192			3515	3522	3512	3480	3433	3384	3335	3284	3236	3185	3143	3101	3063	3033	3004	2979	2958	2937	2917	192
190			3173	3180	3171	3439	3393	3344	3297	3246	3199	3118	3107	3064	3027	2997	2968	2943	2922	2901	2881	190
188		3412	3431	3438	3429	3398	3353	3305	3258	3208	3161	3111	3070	3027	2991	2960	2931	2907	2886	2865	2845	188
186	3283	3371	3389	3396	3387	3357	3313	3265	3220	3170	3124	3073	3033	2991	2954	2924	2895	2871	2850	2829	2809	186
184	3242	3329	3347	3351	3345	3316	3273	3226	3181	3132	3086	3036	2996	2954	2918	2888	2859	2835	2814	2793	2773	184
182	3201	3287	3306	3312	3304	3275	3233	3187	3142	3094	3048	2999	2959	2918	2881	2852	2823	2799	2778	2757	2737	182
180	3159	3246	3264	3270	3262	3234	3192	3147	3104	3056	3011	2962	2922	2881	2845	2815	2787	2763	2742	2721	2701	180
178	3118	3204	3222	3228	3220	3193	3152	3108	3065	3018	2973	2924	2885	2844	2809	2779	2751	2727	2706	2685	2665	178
176	3077	3162	3180	3186	3179	3152	3112	3069	3026	2980	2935	2887	2848	2808	2772	2743	2715	2691	2670	2649	2629	176
174	3035	3121	3138	3144	3137	3112	3072	3029	2988	2942	2898	2850	2811	2771	2736	2707	2679	2654	2631	2613	2593	174
172	2994	3079	3096	3102	3095	3071	3032	2990	2949	2904	2860	2813	2774	2735	2699	2670	2643	2618	2598	2577	2557	172
170	2953	3037	3055	3060	3054	3030	2992	2951	2910	2866	2822	2775	2738	2698	2663	2634	2697	2582	2562	2541	2521	170
168	2911	2996	3013	3018	3012	2989	2951	2911	2872	2828	2785	2738	2701	2661	2627	2598	2570	2546	2526	2505	2485	168
166	2870	2954	2971	2976	2970	2948	2911	2872	2833	2790	2747	2701	2664	2625	2590	2562	2534	2510	2490	2469	2419	166
164	2829	2912	2929	2934	2923	2907	2871	2833	2794	2752	2709	2664	2627	2588	2554	2525	2493	2174	2454	2433	2413	164
162	2787	2871	2887	2892	2887	2866	2831	2793	2756	2714	2672	2626	2590	2552	2517	2489	2462	2438	2418	2397	2377	162
160	2746	2829	2845	2850	2845	2825	2791	2754	2717	2676	2634	2589	2553	2515	2481	2453	2426	2402	2382	2361	2341	160
158	2704	2788	2804	2808	2803	2784	2751	2714	2679	2638	2597	2552	2516	2478	2445	2417	2390	2366	2346	2325	2305	158
156	2663	2746	2762	2766	2762	2743	2710	2675	2640	2600	2559	2515	2479	2442	2408	2380	2354	2330	2310	2289	2269	156
154	2622	2704	2720	2724	2720	2702	2670	2636	2601	2562	2521	2477	2442	2405	2372	2344	2318	2294	2274	2253	2233	154
152	2580	2663	2673	2682	2678	2661	2630	2596	2563	2524	2484	2440	2405	2369	2335	2308	2282	2253	2238	2217	2197	152
150	2539	2621	2636	2640	2637	2620	2590	3557	2524	2486	2446	2403	2369	2332	2299	2272	2246	2222	2202	2181	2161	150
148	2498	2579	2594	2598	2595	2579	2550	2518	2485	2448	2408	2366	2332	2295	2263	2235	2209	2186	2165	2145	2125	148
146	2456	2538	2553	2556	2553	2538	2510	2478	2447	2410	2371	2329	2295	2259	2226	2199	2173	2150	2129	2109	2089	146
144	2415	2496	2511	2514	1511	2197	2470	2439	2408	2372	2333	2291	2258	2222	2190	2163	2137	2114	2093	2073	2053	144
142	2374	2454	2469	2472	2470	2456	2429	2400	2369	2334	2295	2254	2221	2186	2153	2126	2101	2078	2057	2037	2017	142
140	2332	2413	2427	2430	2428	2415	2389	2360	2331	2296	2258	2217	2184	2149	2117	2090	2065	2042	2021	2001	1981	140
138	2291	2371	2385	2388	2386	2374	2349	2321	2292	2258	2220	2180	2147	2112	2081	2054	2029	2006	1985	1965	1945	138
136	2249	2330	2343	2346	2345	2333	2309	2281	2254	2220	2183	2142	2110	2076	2044	2018	1993	1970	1949	1929	1909	136
134	2208	2288	2301	2304	2303	2292	2269	2242	2215	2182	2145	2105	2073	2039	2008	1981	1957	1934	1913	1893	1873	134
132	2167	2246	2260	2262	2261	2251	2229	2203	2176	2144	2107	2068	2036	2003	1971	1945	1921	1898	1877	1857	1837	132
130	2125	2205	2218	2220	2220	2210	2188	2163	2138	2106	2070	2031	2000	1966	1935	1909	1885	1862	1841	1821	1801	130
128	2084	2163	2176	2178	2178	2169	2148	2124	2099	2068	2032	1993	1963	1929	1899	1873	1848	1826	1805	1785	1765	128
126	2043	2121	2134	2136	2135	2128	2108	2085	2060	2030	1994	1956	1926	1893	1862	1836	1812	1790	1769	1749	1729	126
124	2001	2080	2092	2094	2094	2088	2068	2045	2022	1992	1957	1919	1889	1856	1826	1800	1776	1753	1733	1713	1693	124
122	1960	2038	2050	2052	2053	2047	2023	2006	1983	1954	1919	1882	1852	1820	1789	1764	1740	1717	1697	1677	1657	122
120	1919	1996	2009	2010	2011	2006	1988	1967	1914	1916	1881	1844	1815	1783	1753	1728	1704	1681	1661	1641	1621	120
118	1877	1955	1967	1968	1969	1965	1947	1927	1906	1878	1844	1807	1778	1746	1717	1691	1668	1645	1625	1605	1585	118
116	1836	1913	1925	1926	1928	1924	1907	1888	1867	1840	1806	1770	1741	1710	1680	1655	1632	1609	1589	1569		116
114	1795	1871	1883	1884	1886	1883	1867	1849	1828	1802	1768	1733	1704	1673	1644	1619	1596	1573	1553			114
112	1753	1830	1841	1842	1844	1842	1827	1809	1790	1761	1731	1695	1667	1637	1607	1583	1560	1537				112
110	1712	1788	1799	1800	1803	1801	1787	1770	1751	1726	1693	1658	1631	1600	1571	1516	1524					110
108	1670	1747	1758	1758	1761	1760	1747	1730	1713	1688	1656	1621	1594	1563	1535	1510						108
106	1629	1705	1716	1716	1719	1719	1706	1691	1674	1650	1618	1584	1557	1527	1498							106
104	1588	1663	1671	1674	1677	1678	1665	1652	1635	1612	1580	1546	1520	1490								104
102	1546	1622	1632	1632	1636	1637	1626	1612	1597	1574	1543	1509	1483	1454								102
100	1505	1580	1590	1590	1594	1596	1586	1573	1558	1536	1505	1472	1416									100
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	
*	20.68	20.82	20.92	21	20.85	20.48	20.68	19.68	19.32	19	18.82	18.62	18.45	18.39	18.29	13.13	18.05	13.02	18.01	18	18	

* Weight Deviation Multiplier. *Reproduced with permission of Frederick Rand Rogers.*

1. Norms for individuals whose weights are above limits for which norms are included are calculated by adding to the norm for any chosen weight the pound difference between that weight and the individual's weight *times* the Weight Deviation Multiplier.

2. Norms for men over 38 years of age may be calculated roughly by subtracting twenty points from the 38-year norm for each year over 38.

the dynamometer vigorously and repeat measurements were taken with each hand. The best score of the two trials was recorded and the normative data appears in Table XLV.

TABLE XLV

GRIP STRENGTH NORMS
(CAHPER - CANADIANS)

Percentile	Age Group 18 -.19		20 - 24		25 - 34		35 - 44	
	Right	Left	Right	Left	Right	Left	Right	Left
100	75*	68	72	75	80	83	78	82
95	64	62	67	63	69	70	69	68
90	61	57	65	61	68	67	65	62
85	59	56	63	59	66	63	64	60
80	58	53	61	58	64	60	62	59
75	55	52	60	56	62	59	59	58
70	53	51	58	55	61	57	58	56
65	52	50	56	54	60	56	57	56
60	51	48	55	53	59	56	56	55
55	50	48	54	52	58	55	55	54
50	50	47	54	51	57	54	53	52
45	48	46	53	50	56	53	53	52
40	47	45	51	49	55	51	52	50
35	47	44	50	48	54	50	50	49
30	46	43	49	47	52	49	49	47
25	45	43	48	45	50	48	48	45
20	43	42	45	44	48	46	47	44
15	43	41	43	43	47	45	46	41
10	42	39	43	39	45	43	43	39
5	38	37	40	38	41	37	40	36

*All measurements in kilograms

CHAPTER III

METHODS AND PROCEDURES

SAMPLING TECHNIQUE

Information regarding the location, officers and population statistics of Indian reserves in the provinces of British Columbia, Alberta and Saskatchewan was obtained from the respective Departments of Indian Affairs and Northern Development. Coupling this information with road accessibility, the total number of Indian reserves lying between 53.5°N and 60°N latitude was recorded in each province. As there were an unequal number of reserves in the provinces, a proportionate random sample was drawn from each province. This technique generated the following sample:

1. Six bands from British Columbia
2. Four bands from Alberta
3. Two bands from Saskatchewan

The chiefs of these bands were contacted by letter explaining the procedure and requesting permission to conduct the testing. Of the twelve letters sent out, the response was as follows:

Positive response	3
Negative response	1
No response	8

A follow-up letter was sent to those not responding but this produced no further results.

It was decided to travel to as many bands chose in the sample as possible despite the lack of response. Consent was received and testing conducted at the following bands during the period July 12, 1971 to August 13, 1971.

1. British Columbia (total possible number of bands = 18)

   Stoney Creek Band - located nine miles southwest of Vanderhoof, B. C.

   Necoslie Band - located at Fort St. James, B. C.

   Nautley Band - located four miles northwest of Vanderhoof, B. C.

2. Alberta (total possible number of bands = 10)

   Sturgeon Lake Band - located ten miles west of Valleyview, Alberta.

   Driftpile Band - located on the south shore of Lesser Slave Lake, 17 miles west of the town of Kinuso.

   Saddle Lake Band - located 14 miles south of Spedden, Alberta.

3. Saskatchewan (total possible number of bands = 8)

   Onion Lake Band - located 34 miles north of the town of Lloydminster.

   Meadow Lake Band - located one mile east of Meadow Lake, Saskatchewan.

   NOTE: Subjects visiting the above two bands from other bands in Saskatchewan were tested at both of the above areas.

SELECTION OF THE SUBJECTS

Upon arriving at a reserve, contact was made with the band office or the Department of National Health and Welfare nurse's office at which was obtained a person to act as interpreter and assist in recruiting subjects. In some cases posters had been previously printed informing the men of the reserve that the testing was being conducted and some subjects were obtained this way. In addition, the interpreter was driven to homes on the reserve where additional subjects were gained, sometimes with great difficulty. The response from the various bands varied and the reader is referred to the

appendix for the total number of males living in each band. All subjects who volunteered were allowed to take the tests.

DESCRIPTION OF THE APPARATUS

Back and Leg Dynamometer - The dynamometer is a scale mounted on a stall bar bench or wooden platform upon which the subject stands. The chain and the handle attached to it provide for adjustment according to the size of the subject. The scale measures from 0 to 2500 pounds and is divided into units of ten pounds. In addition to the dial hands, there is a maximum indicator that remains in place after maximum effort by the subject.

Stoelting Grip Strength Manuometer - This is a metal device used to record the strength of the finger flexors. The scale reads in kilograms from zero to 100 and is divided into units of one kilogram. The handle is adjustable to fit any size hand and the instrument possesses a maximum indicator from which readings are taken.

Harpenden Skinfold Calipers - These are metal calipers exerting a constant pressure of 10 grams/square millimeter throughout the range of openings from 0 to 52 millimeters. The dial is graduated on the outer scale in two-tenth millimeter divisions while the inner scale registers centimeters from zero to four. A small adjusting knob allows the caliper to be zeroed before each use.

Apparatus for Dips and Chins - The laboratory technicians at the University of Alberta Physical Education Department transformed a classroom desk into a portable apparatus on which dips could be performed. Two vertical supports with wooden handles mounted at the top were bolted to the desk frame at midpoint which allowed for free

movement throughout the whole range of motion involved in executing dips.

A portable chinning bar manufactured by the Weider Corporation was placed between a door frame for the chin up test.

Collins Wet Vitalometer - A six liter stainless steel wet spirometer was used for the vital capacity and one-second forced expiratory volume measures. For the latter measurement, the spirometer had an electrically operated timing device attached which could be set manually before the test to one, two or three seconds. The mechanism automatically stopped one of the two indicator needles at the appropriate time (one second) during the forceful exhalation.

Monark Bicycle Ergometer - This device was used for the physical work capacity test and is manufactured in Varburg, Sweden. The gearing and circumference of the wheel have been so dimensioned that one complete turn of the pedals moves a point on the rim a distance of six meters. The wheel is braked mechanically by a belt running around the rim. Both ends of this belt are attached to a revolving drum to which a pendulum is fixed. The device acts as a pendulum scale, measuring the difference in force at the two ends of the scale. The belt can be tightened with a lever attached to a handwheel and the resulting deflection is read off from a scale graduated in kiloponds. The seat is adjustable to accomodate different sized individuals.

Sanborn Viso-Cardiette 500 - This portable electrocardiogram was used to monitor heart rate while the subjects were engaged in the physical work capacity test on the bicycle ergometer. The machine has a variable paper speed control which was set to run at 25 millimeters

per second during the testing procedure. Heart rate was obtained by measuring the distance of three beats and converting to beats per minute by means of a chart which appears in the appendix.

CALIBRATION OF THE APPARATUS

Back and Leg Dynamometer - The Engineering Department of the University of Alberta calibrated the dynamometer on February 16, 1971 by applying known forces and recording the scale reading on the dynamometer. The correction factors appear in the appendix. All results reported in this study were obtained by applying the appropriate calibration factor.

Monark Bicycle Ergometer - Calibration was carried out immediately before the testing began and repeated during the testing period. Calibration involves fixing the scale at zero, and then hanging known weights to the free pendulum and adjusting a movable core in the pendulum to bring the reading into line with the scale. This procedure was repeated at settings of two, four, and six kilograms and adjusted accordingly.

DESCRIPTION OF THE TESTS

Upon arriving at the testing center the subjects were asked to remove all clothing except their slacks and the tests were administered in the following order in the way described:

Height and Weight: Height was taken in bare feet, with the subject standing against a wall, using a straight edge and a cloth measuring tape attached to the wall. Heights were recorded to the nearest half inch.

Weight was taken on a portable bathroom scale previously set to zero. Weight was recorded to the nearest pound and converted into kilograms according to the following conversion:

$$\text{kg.} = \text{actual weight (pounds)} / 2.2$$

Grip Strength. The standing subject grasped the Stoelting manuometer after it had been adjusted to fit his hand and was asked to raise his hand above his head. The subjects were instructed to gradually increase the force applied until they had reached a maximum. In most cases the arm was brought down from above the head to beside the body, but at no time was the arm allowed to contact the body. Two trials were allowed with each hand according to the following procedure: right grip, rest, left grip, rest; right grip, rest, left grip. Maximum recordings were taken to the nearest kilogram and converted to pounds according to the following conversion:

$$\text{pounds} = \text{kilograms} \times 2.2$$

Trials in which a final jerking squeeze was apparent were not allowed. In such cases, a rest pause was taken and another trial made. The results appearing in this study are the average of the two trials.

Leg Lift. The dynamometer stool was placed against a flat wall to minimize any backward lunging. The subject stood on the stool with his feet parallel and shoulder width apart. A metal bar was gripped by the subject with both hands prone and with the arms slightly bent. Attached to the bar and leading around the subject's back at hip level was a three inch web belt, which aided the subject in performing a maximal lift. The belt rested just over the top edge of the iliac crest. The subject was asked to bend his knees until an angle of

approximately 120 degrees was reached. The chain was attached to the hook on the bar and, after checking to ensure that the subjects were positioned properly, a pull exerted gradually up to a maximum was made by having the subject attempt to straighten his legs. No lunging was allowed and two trials were made. The score recorded to the nearest five pounds is the average of the two trials with the appropriate conversion applied according to the calibration sheet found in the appendix.

Back Lift. After a one minute rest period following the leg lift, the belt was discarded and the subject remained on the stool. The subject was asked to stand erect and hold his arms straight down with fingers extended over his thighs. The bar was placed approximately two inches below finger level and the subject bent over from the hips keeping his legs straight and grasped the bar with one hand prone and one supine. The chain was adjusted and attached so that with a gradual pull up to a maximum, the subject's back ended up vertical or just touching the wall. No lunging was allowed. Scores were recorded as with the leg lift.

Chins. The Weider portable chinning bar was firmly attached in a door frame and the subject grasped the bar with palms facing himself. The subject was asked to bend his knees where necessary to allow the arms to straighten after which he pulled up until his chin was even with the bar. This procedure was repeated to ensure that the floor was not contacted and each chin commenced from a straight arm hanging position. The maximum number of chins done in one trial was recorded to the nearest half.

Dips. The subject stood between the two vertical posts and placed

his hands on the moulded wooden grips. Instructions were given along with a demonstration to ensure that the subject did not contact the floor and each time he lowered himself, his elbow joint formed a right angle. The mounting of the apparatus was counted as one dip and the maximum number done was recorded to the nearest half.

Skinfold Measurements: All skinfold measurements were made on the right side of the body using a Harpenden Skinfold caliper. All measurements were made by the same practiced examiner. The folds were firmly grasped between the left thumb and forefinger and the caliper jaws were placed about one centimeter away from the fingers and halfway between the crest of the fold and the underlying musculature. In doubtful cases, the subject was asked to contract the underlying musculature to ensure that only subcutaneous tissue was being measured. The folds were recorded to the nearest millimeter after all movement of the indicator needle had ceased. Measurements were made in the following order:

1. Triceps - with the subject standing and the right arm flexed loosely at 90 degrees the fold was grasped in a vertical plane halfway between the acromion process and the olecranon process.

2. Subscapular - with the subject standing and arms hanging loosely at the sides, the right scapula was palpated to locate the medial border about one inch superior to the tip. The fold was grasped at an angle of 45 degrees to the vertical.

3. Chest - with the subject standing and the arms hanging loosely at the side, the fold was grasped one inch laterally and one inch superior to the right nipple at an angle of 45 degrees to vertical along the line formed by the pectoralis major muscle.

4. Abdomen - with the subject standing and the arms hanging loosely at the sides, the fold was grasped one inch to the right of the navel in a vertical plane.

Forced Expiratory Volume$_{1.0}$ and Vital Capacity: The subject stood in front of the Collins vitalometer and was instructed to grasp the

connecting tube in his right hand. He then performed a maximal inhalation, plugged his nose with his left hand, and expired air as fast and as long as possible. Two trials were allowed, with the maximum volumes being recorded. The electric switch attached to the vitalometer stopped one of the two indicator needles at the end of one second expiration while the other indicator needle continued to record the vital capacity.

Physical Work Capacity: The subject mounted the bicycle and the seat was adjusted to a height which allowed for a slight bend in the knee with the pedal at the bottom. Two electrodes covered with sufficient electrode paste were attached just below and medial to the nipples while a third was attached on the subject's back. Resting heart rate was recorded and the test commenced if the heart rate was below 100 beats per minute. A metronome was set to establish a pedalling frequency of sixty revolutions per minute. The continuous recording electrical counter which was attached to the bicycle was set to zero and the subject began pedalling at zero load until he had established the required frequency of pedalling. The first load was then applied. The initial loads varied between .5 and 1 kilopond depending on the age and condition of the subject. The subject pedalled at the first load for four minutes with readings of heart rate and revolutions being taken during the last fifteen seconds of the second and fourth minute. The load was increased usually .5 to 1 kilopond at the start of the fifth minute and the subject pedalled for another four minutes at the new load. Readings of heart rate and revolutions were taken during the last fifteen seconds of the sixth and eighth minutes. The third load was applied by

increases of .5 to 1 kilopond in order to create enough work to elicit a final heart rate above 120 to 130 beats per minute. The subject pedalled for another four minutes with readings of heart rate and revolutions being taken during the last fifteen seconds of the tenth and twelfth minutes. At the end of the twelfth minute, the test was terminated.

Questionnaire: In order to gain information relating to work status, activity status, nutritional status, medical status and smoking and alcohol consumption, selected subjects were asked a series of questions after completion of the test battery. The questionnaire used appears in the appendix.

Statistical Procedures: The statistics included the following calculations:

1. One way analysis of variance to test for significant differences between the means of the eight bands on twelve parameters.

2. Two way analysis of variance to test for significant differences between the age groups and between the provinces on twelve parameters.

3. T-tests for significance of differences between the means of smokers and non-smokers, drinkers and non-drinkers, and those employed and not employed.

4. Intercorrelations between all parameters.

5. Percentile norms for selected parameters.

CHAPTER IV

RESULTS AND DISCUSSION

CHARACTERISTICS OF THE SUBJECTS

A total of 189 volunteer subjects participated in this study from eight bands in the three western provinces of British Columbia, Alberta and Saskatchewan. Table XLVI presents some characteristics of the subjects studied.

TABLE XLVI

CHARACTERISTICS OF THE SUBJECTS

Age Group	N	Mean Age (years)	Mean Height (inches)	Mean Weight (lbs.)	(kg.)
20 - 29	66	23.3	69.5 (59.0 - 73.5)*	150.1 (108 - 215)	63.3
30 - 39	59	33.8	70.5 (63.0 - 79.0)	173.1 (114 - 260)	78.6
40 - 49	34	45.5	70.1 (64.0 - 74.0)	179.8 (144 - 240)	81.6
50 - 62	30	55.9	69.8 (65.5 - 74.0)	185.2 (130 - 260)	84.1
Total Group	189	39.6 (20 - 62)	67.5 (59.0 - 79.0)	172.1 (114 - 260)	76.9

*Range

QUESTIONNAIRE RESULTS

Subjects verbally responded to the questionnaire appearing in the appendix. However, due to various difficulties at each of the

eight reserves where testing was conducted, not all subjects responded to all parts of the questionnaire.

Smoking Habits

Subjects were asked whether or not they smoked cigarettes, pipes, cigars or used chewing tobacco. For purposes of the analyses which appear later in this chapter, those who smoked were grouped as (1) one package per day or more, or (2) one-half to one package per day. Those smoking less than this were not used in the analyses. The results appear in Table XLVII.

TABLE XLVII

SMOKING HABITS

Number of Respondents	Percentage of Smokers	Percentage of Non-smokers	Amount 1-10	Smoked 10-25	Per Day 25
149	88%	12%	52	72	10

NOTE: No subjects reported significant use of pipes or cigars, however, 15 subjects used chewing tobacco.

Drinking Habits

Subjects were asked whether they drank alcoholic beverages of any type and how frequently they used alcohol. The results appear in Table XLVIII.

TABLE XLVIII
DRINKING HABITS

Number of Respondents	Percentage of Drinkers	Percentage of Non-drinkers	Frequency per Week 1-2	2-3	3-4	5 and up
147	84%	16%	36*	62	15	11

*Number of respondents

Employment Status

Subjects responded to questions on the nature of their work if employed, frequency of working or unemployment status. For purposes of statistical analysis later in this chapter, persons who were employed for six months or over during the last year were classified as employed, while those who worked only occasionally or were employed for less than six months during the last year were classified as unemployed. The results of this aspect of the study appear in Table XLIX.

TABLE XLIX

EMPLOYMENT STATUS

Number of Respondents	Percentage Employed	Percentage Not Employed
136	52	48

NOTE: The majority of those employed worked on farms as farmhands, as laborers with nearby industries, or were employed by the band councils.

Recreational Habits

Responses to questions concerning leisure time pursuits revealed that the most common activities included: watching television, trapping, hunting and fishing, horseback riding, and playing organized sports (especially baseball and hockey). A number of respondents indicated that they merely do nothing in their spare time but walk around and visit neighbors, while a smaller number indicated that they regularly do vigorous work such as digging wells and cutting wood. Surprisingly few people participated in any hobbies or handicrafts in

their spare time, however this is primarily woman's work.

Nutritional and Medical Status

Most of the respondents indirectly indicated that they obtain a reasonably well-balanced diet of proteins, carbohydrates, and fats. However, there appeared to be an extremely heavy dependence upon carbohydrate foods such as potatoes, bread or banak (similar to bread or crackers). Many respondents indicated that they consumed potatoes with all three meals each day. Cursory examination of the existence of excessive amounts of subcutaneous fat tended to support the fact that caloric intakes exceeded daily requirements. Analysis of this factor will be reported later in this chapter.

None of the respondents indicated they were taking vitamin supplements and very few drank milk. There was a large dependence on wild meats such as moose, deer, beaver, muskrat, rabbit and ducks, however, most respondents did eat beef, pork and chicken in varying amounts. The majority of respondents had fruits and vegetables in their diets but a significant number did not eat these every day. In some cases no fruits or vegetables were eaten at all.

Most of the respondents had received a medical examination by a doctor at some time in the past few years and all bands had the services of a health nurse employed by the Department of National Health and Welfare. Most of the subjects appeared healthy with the exception that there was a tremendous amount of tooth decay present. In addition, consultation with the respective health nurses revealed that the primary health problem was diarrhea. This could be related to many factors, perhaps the most significant of which would be impurities in the water supply. All bands visited were dependent upon

individual wells, some of which contained water tested and found unfit for drinking.

Personal cleanliness was lacking in almost all subjects tested - a condition directly attributable to the fact that most homes did not have running water or bathrooms and consequently bathing is difficult and most often neglected.

Physical Fitness Test Results

Statistical analyses were carried out using an Olivetti 101 Programma, a Sony calculator and the IBM 360/67 computer installation at the University of Alberta. Source programs were obtained from the University of Alberta Division of Educational Research Services publication entitled Program Documentation (1968). The analyses included the following:

1. Two-way analysis of variance for the significance of difference between age groups and between provinces on twelve parameters.

2. Percentile norms for the entire sample were calculated on twelve parameters.

3. An intercorrelation matrix was calculated for all parameters. This matrix appears in the appendix.

4. T-tests for the significance of difference between smokers and non-smokers on four parameters.

5. T-tests for the significance of difference between drinkers and non-drinkers on three parameters.

6. T-tests for the significance of difference between those employed and those not employed on twelve parameters.

7. One-way analysis of variance for the significance of difference between bands on twelve parameters.

Age Group Comparisons

The main hypothesis asserts that no difference exists between the four age groups in this study on any of the twelve parameters measured. In order to test this hypothesis and one of the subsidiary hypotheses regarding provincial differences, a two-way analysis of variance utilizing a least squares solution was conducted.

The two-way analyses were preceeded by conducting a chi-square test for independence between factor A (age group) and factor B (province). As the number of observations in each of the cells varied only slightly over all twelve parameters, the observed frequencies on the vital capacity test were utilized for the test of independence, and the result from this test was assumed to be correct for all twelve parameters. The chi-square test provides a measure of the discrepancy between observed cell frequencies and those expected on the basis of independence.

Table L presents a summary of the chi-square test for independence. As can be seen from the analysis, the obtained chi-square value did not reach significance at the .10 level of significance and therefore the classification variables of province and age group are independent of each other.

For purposes of analysis the subjects were grouped into one of four age groups based upon their age on the date of testing as well as into the province where the band was located. Only the age group results are presented in this section while the provincial comparisons appear later in this chapter. The reader is referred to tables presenting the results of a two way analysis of variance, however reference will only be made to the age group factor of this analysis in this section.

TABLE L

CHI-SQUARE TEST FOR INDEPENDENCE

Factor A - Age Group	British Columbia	Alberta	Saskatchewan	Totals
20 - 29	Ob.* 16.00 Ex.** 18.29	Ob. 29.0 Ex. 24.39	Ob. 21.0 Ex. 20.14	66
30 - 39	Ob. 17.0 Ex. 15.80	Ob. 23.0 Ex. 21.07	Ob. 17.0 Ex. 20.14	57
40 - 49	Ob. 8.0 Ex. 8.59	Ob. 9.0 Ex. 11.45	Ob. 14.0 Ex. 10.95	31
50 - 62	Ob. 10.0 Ex. 8.31	Ob. 7.0 Ex. 11.09	Ob. 13.0 Ex. 10.60	30
Totals	51	68	65	184

Obtained Chi-square	D.F. (Row - 1 x Column - 1)	$x^2(6)$ at .10 level
5.9725	6	10.64

* Observed cell frequency
** Expected cell frequency

Included as part of the two-way analysis of variance program (ANOV25) was a test for additivity to determine if an interaction effect was present as well as Sheffe's multiple comparison of main effects for factor A and factor B. In all cases except back lift and predicted maximal oxygen uptake, the test for additivity produced non-significant F-ratios indicating that no interaction effect was present. Thus, the least squares solution under the additivity assumption (ie. no interaction) was used for all two-way analyses of variance with the exception of the two parameters mentioned above. With these two cases, in which interaction was present, the main effects for age were not tested. Because of the nature of the study, no analysis of simple effects was carried out as the information which might be obtained could be estimated, if desired, from examination of the means matrix which appears in Table LI.

Vital Capacity - Age Groups

The analysis of variance procedure revealed a significant F-ratio for age group indicating there was a difference between the age groups on vital capacity. Table LII presents a summary of this analysis. Only the age group F-ratios are of interest while the provincial F-ratios will be referred to later in the chapter.

TABLE LII
ANALYSIS OF VARIANCE - VITAL CAPACITY
PROVINCE AND AGE GROUP

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(3,178 2, 178) at .05
Age Group	6.408	2.13608	3	4.752	.003	2.66
Province	31.293	15.6467	2	34.808	.000002	3.05
Error	80.011	.44950	178	-	-	-

TABLE LI

MEANS MATRIX FOR AGE GROUPS
ALL PARAMETERS

Age Group	Vital Capacity (liters)	$FEV_{1.0}$ (liters/sec)	Left Grip (kg)	Right Grip (kg)	Back Lift (lbs)	Leg Lift (lbs)
20 - 29	4.65 (.51)* N = 67	3.88 (.71) N = 66	49.3 (7.9) N = 65	50.5 (8.0) N = 63	334.3 (74.6) N = 63	763.2 (198.0) N = 64
30 - 39	4.35 (.70) N = 56	3.40 (.82) N = 59	48.8 (8.6) N = 59	50.1 (9.0) N = 57	350.7 (79.4) N = 59	717.0 (241.6) N = 58
40 - 49	3.81 (.64) N = 31	2.82 (.63) N = 33	46.6 (8.1) N = 34	47.7 (6.9) N = 34	339.2 (86.9) N = 32	772.7 (262.1) N = 31
50 - 62	3.41 (.91) N = 30	2.50 (.80) N = 29	42.3 (7.3) N = 31	44.9 (7.2) N = 31	312.6 (71.4) N = 29	610.0 (229.5) N = 29
Overall	4.22 (.80) N = 184	3.31 (.89) N = 187	47.5 (8.4) N = 189	48.9 (8.2) N = 185	336.9 (78.1) N = 183	725.7 (233.1) N = 182

* Standard Deviation

TABLE LI

(CONTINUED)

Age Group	Arm Strength	Strength Index	Total Skinfold (mm)	Percent Body Fat %	MVO_2 (ml/kg/min)	PWC_{170}/kg (kpm/min)
20 - 29	330.3 (137.7) N = 62	1917.3 (346.8) N = 60	50.9 (24.5) N = 66	8.6 (3.9) N = 66	41.3 (7.6) N = 60	14.5 (3.6) N = 61
30 - 39	230.1 (137.1) N = 58	1776.8 (394.8) N = 57	73.7 (36.3) N = 58	12.5 (6.0) N = 58	34.9 (8.5) N = 54	14.1 (3.9) N = 55
40 - 49	175.1 (123.6) N = 33	1728.5 (433.9) N = 31	86.6 (32.4) N = 34	17.3 (4.9) N = 34	29.9 (4.5) N = 22	13.7 (3.2) N = 29
50 - 62	119.3 (99.3) N = 28	1468.4 (321.7) N = 28	92.2 (45.5) N = 30	20.4 (6.6) N = 30	24.9 (7.1) N = 20	11.9 (2.8) N = 23
Overall	237.3 (149.4) N = 181	1767.1 (400.6) N = 176	71.0 (36.9) N = 188	13.2 (6.8) N = 188	35.4 (9.3) N = 156	13.9 (3.6) N = 168

Scheffee's multiple comparison of the main effect for age group utilizing the .10 level of significance is presented in Table LIII. This test revealed the location of the difference on vital capacity as being between age group 20 - 29 and 50 - 62 as well as between age group 30 - 39 and 50 - 62.

Forced Expiratory Volume$_{1.0}$ - Age Groups

Due to the relationship between one-second forced expiratory volume and vital capacity in normal individuals (cited 34), it was expected that the age group main effect would reach significance at the .05 level. The analysis of variance presented in Table LIV confirmed this expectation as the F-ratio was significant beyond the .01 level. Scheffe's multiple comparison of the age group effect is presented in Table LV shown on page 84, and localized the differences as occurring between:

Age Groups 20 - 29 and 50 - 62
30 - 39 and 50 - 62
40 - 49 and 50 - 62

TABLE LIV

ANALYSIS OF VARIANCE - FEV$_{1.0}$
PROVINCE AND AGE GROUP

Source	Sum of Squares	Mean Square	Degree of Freedom	F-ratio	P	F(3,182 2, 182) at .05
Age Group	13.3342	4.445	3	7.819	.00006	3.05
Province	29.4964	14.748	2	25.944	.000002	2.66
Error	103.458	.5684	182	-	-	-

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[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE LIII

SCHEFFE COMPARISON OF MAIN EFFECTS - VITAL CAPACITY
AGE GROUPS AND PROVINCES

A. Age Groups	Contrast	F-ratio	Probability
1 - 2	.17323	.588	.623
1 - 3	.23098	.814	.487
1 - 4	.53549	4.66*	.003
2 - 3	.05774	.053	.983
2 - 4	.36225	2.20*	.089
3 - 4	.30451	1.27	.286

B. Provinces	Contrast	F-ratio	Probability
1 - 2	.39205	5.52*	.004
1 - 3	.10588	34.80*	.000
2 - 3	.66680	12.06*	.000

* Significant at .10 level

NOTE: A. Age Groups

1 is 20 - 29
2 is 30 - 39
3 is 40 - 49
4 is 50 - 62

B. Province

1 is British Columbia
2 is Alberta
3 is Saskatchewan

TABLE LV

SCHEFFE COMPARISON OF MAIN EFFECTS - $FEV_{1.0}$
PROVINCE AND AGE

A. Age Groups	Contrast	F-ratio	Probability
1 - 2	.2482	.9712	.407
1 - 3	.2224	.6044	.612
1 - 4	.7504	7.5839*	.000
2 - 3	-.0258	.0085	.999
2 - 4	.5022	3.453*	.017
3 - 4	.5280	3.097	.028
B. Provinces			
1 - 2	.4513	5.922*	.003
1 - 3	1.015	25.721*	.000
2 - 3	.5633	7.027*	.001

* Significant at .10 level

Left Grip - Age Groups

Significant differences between age groups was evident from the analysis of variance presented in Table LVI. The differences occurred between age group 20 - 29 and 50 - 62 and between age group 30 - 39 and 50 - 62 as is apparent from Scheffe's test appearing in Table LVII.

TABLE LVI

ANALYSIS OF VARIANCE - LEFT GRIP
PROVINCE AND AGE GROUP

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(3, 182 2, 182) at .05
Age Group	686.680	228.893	3	3.429	.018	3.05
Province	49.662	248.314	2	3.719	.026	2.66
Error	12150.4	66.761	182	-	-	-

Right Grip - Age Groups

The results of the analysis of variance for right grip differences between age groups appear in Table LVIII while the Scheffe test revealed the difference as occurring between age group 20 - 29 and 50 - 62. This test is presented in Table LVIX on page 87.

TABLE LVIII

ANALYSIS OF VARIANCE - RIGHT GRIP
PROVINCE AND AGE GROUP

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(3, 180 2, 180) at .05
Age Group	595.239	198.413	3	3.107	.027	3.05
Province	450.427	225.214	2	3.527	.031	2.66
Error	11494.4	63.858	180	-	-	-

TABLE LVII

SCHEFFE COMPARISON OF MAIN EFFECTS - LEFT GRIP
PROVINCE AND AGE GROUP

A. Age Group	Contrast	F-ratio	Probability
1 - 2	.695	.064	.978
1 - 3	1.358	.194	.900
1 - 4	5.074	3.005*	.031
2 - 3	.663	.047	.986
2 - 4	4.379	2.253*	.083
3 - 4	3.716	1.323	.268
B. Province			
1 - 2	.226	.013	.987
1 - 3	3.931	3.269*	.040
2 - 3	3.705	2.635*	.074

* Significant at .10 level

TABLE LIX

SCHEFFE COMPARISON OF MAIN EFFECTS - RIGHT GRIP
PROVINCE AND AGE GROUP

A. Age Group	Contrast	F-ratio	Probability
1 - 2	.111	.171	.915
1 - 3	1.493	.242	.866
1 - 4	4.929	2.89*	.036
2 - 3	.381	.016	.997
2 - 4	3.817	1.77	.154
3 - 4	3.436	1.17	.322
B. Province			
1 - 2	-.237	.014	.985
1 - 3	3.522	2.78*	.064
2 - 3	3.759	2.82*	.061

* Significant at .10 level

Leg Lift - Age Groups

The analysis of variance summarized in Table LX revealed a significant difference in age groups on leg lift strength. Further analysis using Scheffe's comparison of main effects indicated the difference occurred between age groups 20 - 29 and 50 - 62. This analysis is presented in Table LXI.

TABLE LX

ANALYSIS OF VARIANCE - LEG LIFT
PROVINCE AND AGE GROUP

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(3,176,2,176 at .05
Age Group	483037.0	161012.0	3	3.038	.030	3.05
Province	52896.9	26448.4	2	0.499	.608	2.66
Error	9326560.0	52991.8	176	-	-	-

Arm Strength - Age Groups

Table LXII contains the analysis of variance summary which showed that significant differences existed on arm strength between the age groups. Consulting Scheffe's test presented in Table LXIII revealed the location of the differences as being between age group 20 - 29 and 50 - 62, and age group 30 - 39 and 50 - 62.

Strength Index

Age group main effects were found to be significant at the .05 level of significance as is evident from the analysis of variance summary appearing in Table LXIV on page 91. Scheffe's multiple comparison of main effect for age group produced the following

TABLE LXI

SCHEFFE COMPARISON OF MAIN EFFECTS - LEG LIFT
AGE GROUPS

Age Group	Contrast	F-ratio	Probability
1 - 2	48.658	.395	.757
1 - 3	15.741	.032	.757
1 - 4	141.208	2.72*	.045
2 - 3	32.917	.146	.932
2 - 4	92.549	1.185	.317
3 - 4	125.467	1.815	.146

* Significant at the .10 level

TABLE LXII

ANALYSIS OF VARIANCE - ARM STRENGTH
PROVINCE AND AGE GROUP

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(3,175,2,175 at .05
Age Group	165227.0	55075.8	3	3.244	.023	3.05
Province	901799.0	450900.0	2	26.561	.000	2.66
Error	2970750.0	16975.7	175	-	-	-

TABLE LXIII

SCHEFFE COMPARISON OF MAIN EFFECTS - ARM STRENGTH
PROVINCE AND AGE GROUP

A. Age Group	Contrast	F-ratio	Probability
1 - 2	11.678	.070	.975
1 - 3	34.141	.453	.716
1 - 4	80.420	2.84*	.039
2 - 3	22.463	.204	.893
2 - 4	68.742	2.127	.098
3 - 4	46.278	.754	.521
B. Province			
1 - 2	117.747	13.321*	.000
1 - 3	169.023	22.895*	.000
2 - 3	51.275	1.894	.153

* Significant at .10 level

significant differences:

Age Groups	20 - 29 and 50 - 62
	30 - 39 and 50 - 62
	40 - 49 and 50 - 62

This test is summarized in Table LXV.

TABLE LXIV

ANALYSIS OF VARIANCE - STRENGTH INDEX
PROVINCE AND AGE GROUP

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(3,170,2,170 at .05
Age Group	2426350.0	808784.0	3	5.699	.0009	3.05
Province	1436530.0	718264.0	2	5.061	.007	2.66
Error	24122900.0	141899.0	170	-	-	-

Total Skinfold - Age Groups

The analysis of variance in Table LXVI revealed a significant difference between age groups, however the Scheffe multiple comparison of main effects failed to localize the difference. Due to the fact that total skinfold and percent body fat are related, no further analysis was made to locate the difference in total skinfold as the percent body fat analysis following localizes the difference as being between age groups 20 - 29 and 50 - 62. It would be a fairly valid assumption that the difference would occur here and this is further supported by the means of total skinfold for age groups (Table LI).

Percent Body Fat - Age Groups

As mentioned above, a significant F-ratio occurred between age groups on percent body fat while the Scheffe test localized the

[illegible]

TABLE LXV

SCHEFFE COMPARISON OF MAIN EFFECTS - STRENGTH INDEX
PROVINCE AND AGE GROUP

A. Age Group	Contrast	F-ratio	Probability
1 - 2	96.55	.556	.644
1 - 3	96.32	.424	.736
1 - 4	331.7	5.46*	.001
2 - 3	-.217	.000	1.000
2 - 4	235.155	2.860*	.038
3 - 4	235.372	2.276*	.081
B. Province			
1 - 2	47.951	.252	.777
1 - 3	228.503	4.911*	.008
2 - 3	180.551	2.692*	.070

* Significant at .10 level

difference as occurring between age group 20 - 29 and 50 - 62. These two analyses are presented in Tables LXVII and LXVIII respectively.

TABLE LXVI

ANALYSIS OF VARIANCE - TOTAL SKINFOLD
PROVINCE AND AGE GROUP

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(3,182,2,182) at .05
Age Group	6211.99	2070.66	3	1.897	.131	2.66
Province	49982.10	24991.10	2	22.899	.000	3.05
Error	198628.00	1091.36	182	-	-	-

TABLE LXVII

ANALYSIS OF VARIANCE - PERCENT BODY FAT
PROVINCE AND AGE GROUP

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(3,180,2,180) at .05
Age Group	370.635	123.545	3	4.56	.004	3.05
Province	3171.940	1585.970	2	58.53	.00	2.66
Error	4877.50	27.097	180	-	-	-

TABLE LXVIII

SCHEFFE COMPARISON OF MAIN EFFECTS - PERCENT BODY FAT PROVINCE AND AGE GROUP

A. Age Group	Contrast	F-ratio	Probability
1 - 2	1.641	.874	.455
1 - 3	1.509	.563	.640
1 - 4	3.972	4.534*	.004
2 - 3	0.132	.004	.999
2 - 4	2.331	1.560	.200
3 - 4	2.463	1.385	.248
B. Province			
1 - 2	6.026	22.107	.000
1 - 3	10.408	54.656	.000
2 - 3	4.382	8.674	.000

* Significant at .10 level

<u>Physical Working Capacity</u>$_{170/kg.}$ - <u>Age Groups</u>

No significant differences were found between age groups on this parameter as is evident from the analysis of variance summary appearing in Table LXIX.

TABLE LXIX

ANALYSIS OF VARIANCE - PWC$_{170/kg.}$
PROVINCE AND AGE GROUP

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(3,162,2,162) at .05
Age Group	25.133	8.378	3	0.673	.569	3.05
Province	147.25	73.626	2	5.915	.003	2.66
Error	2016.38	12.447	162	-	-	-

This result is not unexpected due to the fact that there is some problem involved in utilizing a physical working capacity test where extrapolations are made to a heart rate of 170 beats per minute for all age groups. It is well-known that maximal heart rates decrease with age (cited 13) and therefore it becomes unrealistic to compare age groups at the same heart rate when this heart rate (ie. 170 beats per minute) represents a different amount of stress depending upon the age of the subject. A younger subject may have a maximum attainable heart rate of 200 beats per minute whereas an older subject may have a maximal heart rate of 175 beats per minute. Therefore, comparisons to a common heart rate of 170 beats per minute do not represent equivalent percentage loads on the two individuals. Referring to the CAHPER normative table on page 38 reveals that a

younger person has to do less work to reach, for example, percentile 50 than an older person. It is questionable whether this, in fact, is valid. It might be wise to make work load comparisons for maximal heart rates for each age group rather than use a common heart rate for each age group when it is known that maximum heart rates decrease with age. This could partially explain why no significant differences were found on physical working capacity$_{170/kg}$.

A graphical representation of age group means on all parameters appears later in this chapter along with the provincial means. The reader is referred to these graphs for visual representation of the means obtained on each of the four age groups.

Percentile Norms - Age Groups

Normative values at each quartile were calculated for the total sample on twelve parameters. Due to the fact that the final sample was not random in nature, caution is advised when using these normative values for comparison with other Canadian Indian groups. As can be seen from an examination of the bands later in this chapter, there was a diversity in the number of subjects tested at each band as well as a diversity in the mean scores, ages and work habits. Because of these facts, the normative values appearing in Table LXX can only be interpreted as being normative for the sample used and not representative of all Western Canadian Indians.

Summary of Age Group Results

The foregoing analyses have presented significant differences between age groups on various parameters. For purposes of synthesis, these results appear below. Those age groups marked with an asterisk

TABLE LXX

PERCENTILE NORMS - ALL PARAMETERS
TOTAL SAMPLE

Parameters	P_{25}	P_{50}	P_{75}	P_{100}*
Vital Capacity (liters)	3.94	4.03	5.12	6.00
$FEV_{1.0}$ (liters/sec)	2.89	3.63	3.69	5.40
Right Grip (kg)	43.25	48.00	54.58	65.00
Left Grip (kg)	42.88	47.00	53.38	71.00
Back Lift (kg)	284.88	335.29	395.00	525.00
Leg Lift (kg)	569.67	695.50	865.00	1380.00
Arm Strength	114.25	216.00	318.00	653.00
Strength Index	1475.50	1742.50	2041.50	2711.00
Total Skinfold (mm)	P_o =** 170.80	88.50	64.59	40.43
Percent Body Fat (%)	P_o =** 37.60	17.55	12.85	7.22
$PWC_{170/kg}$ (kpm/min)	11.65	13.37	15.35	29.00
MVO_2 (ml/kg/min)	28.33	34.50	41.41	65.00

* Maximum score obtained on each parameter.
** P_o = maximum score obtained.

obtained the highest score on the particular measurement.

Vital Capacity	20 - 29* and 50 - 62
	30 - 39* and 50 - 62
$FEV_{1.0}$	20 - 29* and 50 - 62
	30 - 39* and 50 - 62
	40 - 49* and 50 - 62
Left Grip	20 - 29* and 50 - 62
	30 - 39* and 50 - 62
Right Grip	20 - 29* and 50 - 62
Leg Lift	20 - 29* and 50 - 62
Arm Strength	20 - 29* and 50 - 62
	30 - 39* and 50 - 62
Strength Index	20 - 29* and 50 - 62
	30 - 39* and 50 - 62
	40 - 49* and 50 - 62
Percent Body Fat	20 - 29 and 50 - 62*

COMPARISON OF RESULTS WITH WORLD STUDIES

One of the major purposes of this study was to determine the physical fitness levels of Western Canadian Treaty Indian males through the use of selected tests and compare these resulting scores to those obtained on other ethnic groups around the world on similar tests. This would be of value as the initial step towards identification of possible ethnic group differences. Further study could then be initiated to determine whether these differences, if any, are genetically or culturally determined in the hope that remedial programs could be initiated to alleviate any significant disparity.

Unfortunately, comparisons of this nature cannot be made with precise authority due to some or all of the following limitations:

1. Variations in sampling procedures of the groups under study.

2. Failure to adequately describe in detail the characteristics of the subjects under study.

3. Non-standardized testing procedures.

4. Variations in statistical analyses of the data.

5. Difficulty in using more sophisticated equipment in field studies to gain accuracy in measurement.

6. Inter-experimenter error.

7. Use of varied computational formulas for the same parameters which produce different results.

8. Experimental error.

All that can be done at present, until the above limitations are overcome, is that general comparisons can be made and any wide departures from values obtained in other studies should be viewed with suspicion and investigated further to determine the source of the irregularity. With these facts in mind, the following sections compare the results obtained in this study with selected studies reported previously in chapter II.

Maximal Oxygen Uptake

The studies reviewed in chapter II which presented maximal oxygen uptake values for various groups around the world have been synthesized in Table LXXI. The values reported for each grouping of the table are mean values calculated by this author from all the studies. The reader is referred back to chapter II for the individual values presented in each study.

The results of maximal oxygen uptake for the Indian males in this study do not differ markedly from the tabled mean values. Shephard (cited 72) suggests also that values obtained on studies conducted on a bicycle ergometer should be further increased by an additional 7%.

TABLE LXXI

WORLD MEAN MAXIMAL OXYGEN UPTAKE VALUES
(ml/kg/min.)

National Grouping	Age Group and Activity Status 20 - 29 I*	 A	 U	30 - 39 I	A	U	40 - 49 I	A	U	50 - 59 I	A	U	>60 I	A	U
Canada References:	46.0 (36,72)	49.5 (36, 72)	53.0 (65)	39.5 (36, 72)	38.0 (36)	41.0 (65)	36.5 (36, 72)	38.0 (36)	40.0 (65)	35.5 (36, 72)	36.0 (36)				30.0 (65)
United States References:	37.0 (15,72)	52.0 (72)		36.0 (72)			36.0 (72)	43.6 (59, 72)	40.0 (57)			36.5 (57)	36.0 (72)		29.0 (57)
South Africa (a) Natives References: (b) Caucasians References:		 51.0 (82) 48.0 (83)	 47.0 (84)												
Scandinavia References:	52.0 (8,72)	65.5 (7,48, 66,72)		44.0 (72)	47.0 (7,72)		42.0 (67, 68,72)	48.0 (7, 43)		37.0 (6, 67)	41.5 (6,7, 9,43)	34.0 (6)	36.0 (67, 72)	36.6 (7,9, 10,43,72)	
Japan References:	42.3 (49)														
Other Countries References:	45.0 (72)	46.0 (5, 52,72)	42.0 (3)	40.0 (72)	59.0 (72)	45.5 (4,3)	35.0 (72)		38.0 (3)		30.0 (72)	32.0 (3)		25.0 (3)	
Indian Males This Study	41.3 (44.6)**			34.9 (36.7)**			29.9 (32.3)**			24.9 (26.9)**					

* I - inactive, A - active, U - activity status unknown: ** original value increased 8% (see p. 35)

If this increase were made, the results of this study would come closer to the values presented in Table LXXI.

Steadward and Donovan (cited 58) present a table of percentile norms for physical working capacity$_{170}$ on page 32 for members of the Alberta Joggers Club from age 30 - 50+. In addition, Canadian norms for PWC_{170} were established by CAHPER (cited 31). Table LXXII presents the percentile values for Indian males in this study as well as the percentile norms from the Steadward and CAHPER studies closest to which the Indian values lie.

TABLE LXXII

PHYSICAL WORKING CAPACITY$_{170}$ COMPARISONS

Age Group	PWC_{170} (means)	Percentile A*	Percentile B	Percentile C
20 - 29	1252.0	P_{60}	P_{50}	P_{60}
30 - 39	1176.6	P_{55}	P_{45}	P_{65}
40 - 49	1102.6	P_{50}	P_{35}	P_{60}
50 - 62	986.1	P_{25}	P_{40}	-

*A - This study (PWC_{170}/kg.)
B - Steadward's study (PWC_{170})
C - CAHPER study (PWC_{170}/kg.)

When compared to Steadward's subjects (joggers), the Indian males in this study score fairly low. However, most of the Indians were probably not as active as the subjects in Steadward's study and therefore this result is to be expected. Unfortunately, the CAHPER study presents norms only up to age 44 and therefore there was no comparative norm for the 50 - 62 year old age group in this study. The other Indian age groups appear slightly above average when compared to the norms for Canadian males, a finding that is not unrealistic.

Skinfolds and Percent Body Fat

Selected studies presented in chapter II utilizing standard measuring sites, techniques and constant pressure calipers (10 gm/mm^2) were used to construct Table LXXIII which presents the mean skinfold values of all studies at four sites as well as the means of the skinfolds taken in this study.

The skinfold comparisons generally indicate higher values for the Indian males in this study than those reported in the table. However, due to the great diversity of values obtained by different testors on skinfold measurements no justifiable conclusions can be made from the foregoing table. As mentioned earlier, simple observation of the subjects in this study indicated a number of subjects had excess fat which might be the result of their high carbohydrate diets and relative inactivity.

The percentage body fat calculations using the Brozek and Keys (cited 28) formula for the subjects in this study produced the following mean values:

1. Age 20 - 29 8.6% body fat
2. Age 30 - 39 12.5% body fat
3. Age 40 - 49 17.3% body fat
4. Age 50 - 62 20.4% body fat

These values are not out of line with the studies reported in chapter II summarized in Table LXXIV.

It is difficult to draw any meaningful conclusions from the percent body fat data due to the fact that all studies reported made use of different formulas in their calculations and therefore the results are subject to significant variation on this factor alone.

TABLE LXXIII

WORLD MEAN SKINFOLD VALUES
(mm.)

National Grouping	20 - 29 T*	A	S	C	30 - 39 T	A	S	C	40 - 49 T	A	S	C	50 - 59 T	A	S	C
South African Negroes References (76)	8.56				8.38				9.00				11.6			
United States (a) Negroe References	9.1 (60 78)	12.9 (60 78)	13.1 (60 78)													
(b) Caucasian References	8.6 (60 78)	22.4 (27 60 78)	19.3 (27 60 78)	15.9 (27)	11.5 (35 78)	18.0 (78)	14.2 (35 78)		12.5 (23 29)	25.5 (27)	27.5 (23 27 29)	24.5 (27)				
Primitive Peoples References (41)	6.0	7.0	7.4	4.4	6.0	7.4	8.4	4.0								
Canada References (63)	6.7				7.7				7.5 ages 42-68 years							
This Study Indians	9.8	18.4	14.6	10.4	12.6	28.6	18.8	18.4	16.4	28.6	20.4	22.2	18.8	32.4	22.6	24.4

* T = triceps, A = abdomen, S = subscapular, C = chest

TABLE LXXIV

PERCENT BODY FAT - WORLD STUDIES

Nationality	Age Group	Percent Body Fat
New Zealanders	21 - 30	11.6%
References: (62)	31 - 40	14.0%
U. S. Caucasians	mean age 20.3	10.93%
References: (35, 27)	mean age 34.0	22.17%
	mean age 49.0	21.3%
British	age not reported	13.5%
	N = 60	
Western Canadian	20 - 29	8.6%
Treaty Indians	30 - 39	12.59%
(this study)	40 - 49	17.3%
	50 - 62	20.4%

Vital Capacity and Forced Expiratory Volume

The vital capacities of subjects measured in studies reported in chapter II are presented in Table XLIV on page 57. In addition to those reported in this table, Grimby and Saltin (cited 44) report a mean value of 4.89 liters for 152 men between the ages of 20 - 65 years (mean age 40 years), and Erikson (cited 42) reported a mean value of 4.5 liters for ten Eskimos having a mean age of 17.9 years.

The mean values of the subjects in this study were as follows:

age 20 - 29	4.65 liters
age 30 - 39	4.35 liters
age 40 - 49	3.81 liters
age 50 - 62	3.41 liters

The two younger age groups in this study are in line with the values in the cited studies, however the two older age groups of Indian males appear to have vital capacities lower than the same age groups reported in chapter II. This could be interpreted as a significant difference, however this must be done with caution due to the limited number of studies reported.

Consolazio (cited 34) reports that one-second forced expiratory volume should be approximately 83 percent of the vital capacity in normal individuals. Utilizing the mean values of vital capacity and one-second forced expiratory volume for each age group, percentages were calculated using the following formula:

$$\text{percentage} = FEV_{1.0}/\text{vital capacity} \times 100$$

The results of these calculations were:

1. Age Group 20 - 29 83.2%
2. Age Group 30 - 39 78.1%
3. Age Group 40 - 49 74.0%
4. Age Group 50 - 62 73.3%

The two youngest age groups fall close to the normal percentage

[illegible]

of 83%, however, the two oldest age groups are somewhat lower. This may mean that they are significantly abnormal in this relationship.

Using a nomogram of spirometric values in normal males based upon height and age (Amer. J. Med., 30:243, 1961), the mean vital capacities and one-second forced expiratory volumes of each age group in this study were plotted to determine whether they were within normal limits. Using the mean height and mean age of the four age groups, Table LXXV summarizes the findings of this analysis. The nomogram appears in the appendix.

The results of this comparison indicated that all age groups in this study are lower on one-second forced expiratory volume than normal individuals in these age groups. In addition, the two oldest age groups are also lower on the vital capacity measure while the two youngest age groups have above normal values for their respective ages on vital capacity. These findings further substantiate the fact that the older Indian males in this study have inferior scores on these two pulmonary function tests. This could be attributed to three conditions:

1. The majority of the older age group were smokers.
2. Inactivity.
3. Disease conditions in some of the subjects.

Strength

Comparing the mean grip strengths of the two youngest age groups in this study with the Canadian norms established by CAHPER (page 61) reveals the following:

1. Age Group 20 - 29

TABLE LXXV

SPIROMETRIC COMPARISON ON VITAL CAPACITY (LITERS) AND $FEV_{1.0}$ (LITERS/SEC.)

Age Group	Mean Age	Mean Height (in.)	Vital Capacity	$FEV_{1.0}$	Nomogram Value		Percentage Difference	
					Vit. Cap.	$FEV_{1.0}$	Vit. Cap.	$FEV_{1.0}$
20 - 29	23.3	69.5	$4.65 \pm .51$	$3.88 \pm .71$	4.10	4.84	+11%*	-20%
30 - 39	33.8	70.5	$4.35 \pm .70$	$3.40 \pm .82$	4.64	3.80	+15%	-11%
40 - 49	45.5	70.1	$3.81 \pm .64$	$2.82 \pm .63$	4.38	3.50	-13%	-19%
50 - 62	55.9	69.8	$3.41 \pm .91$	$2.50 \pm .80$	4.12	3.20	-15%	-22%

*Plus (+) sign denotes values in this study above normal values.

Negative (-) sign denotes values in this study below normal values.

Right Grip (50.5) - CAHPER percentile P_{40}
Left Grip (49.3) - CAHPER percentile P_{40}

2. Age Group 30 - 39

Right Grip (50.1) - CAHPER percentile P_{25}
Left Grip (48.8) - CAHPER percentile P_{30}

The CAHPER norms are tabulated for people up to age 44 and thus no comparison of the two older age groups could be made. However, it appears that the grip strength of the Indian males in this study is significantly lower than the average Canadian of similar age, at least in the lower two age ranges. This result is difficult to explain but may be due to the relative inactivity of the subjects in this study compared to those in the Canadian sample.

The mean strength index scores were combined with the mean weights and mean ages of the age groups in this study and these values were compared to Rogers table of norms found on page 59. Table LXXVI summarizes the results of these comparisons.

TABLE LXXVI

STRENGTH INDEX COMPARISONS

Age Group	Mean Age (years)	Mean Weight (lbs)	Mean Strength Index	Normative Strength Index
20 - 29	23.3	150.1	1917.3	2620
30 - 39	33.8	173.1	1776.8	2670
40 - 49	45.5	179.8	1728.5	2561*
50 - 59	55.9	185.2	1468.4	2473*

* These values are not tabled but were obtained by subtracting 20 points from the maximum tabled value of 38 years old for each year over 38 according to Roger's recommendations.

[illegible]

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[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

It appears that the strength index of all age groups falls significantly lower than the normative tables prepared by Rogers and therefore the overall strength of the Indian males in this study as measured by the strength index is low compared to what might be expected.

DISCUSSION

The studies cited in chapter II have shown different values for age groups on various parameters. Similarly, the results of the age group comparisons in this study revealed significant differences between the four age groups of Indian males studied. None of the results were surprising as in all cases the younger age groups scored higher (with the exception of percent body fat where they realistically scored lower) as would be generally expected. Young people tend to have higher strength, lung capacity and maximal oxygen uptake scores than older people and the results of this study confirm this. In all cases, the oldest age group (50 - 62) were significantly poorer than their younger counterparts. These differences can simply be explained as normal age group variations.

The percentile norms established in this study are not, however, representative of all Western Canadian Indians for the following two reasons:

1. A non-random sample was obtained due to practical limitations.

2. All bands were located relatively near to settled towns or cities and therefore may differ from bands located in isolated areas. This should be kept in mind when comparisons with other Indian groups are made.

Comparison with results of other studies conducted around the

world revealed two significant findings:

1. The vital capacity and one-second forced expiratory volume of the older age group (50 - 62) in this study are inferior to the other groups reported.

2. The overall strength of the Indians in this study is lower than normative values for Caucasians in North America as reflected in the Canadian grip strength norms as well as Roger's strength index norms.

Most of the Indians studied were relatively sedentary and therefore this could explain the differences found.

In discussing the individual results obtained on the various age groups the following generalizations are justified:

1. There was a gradual decrease in vital capacity and forced expiratory volume with increasing age.

2. There was no significant drop in left or right grip strength from age group 20 - 29 to age group 30 - 39, however, grip strength fell much more quickly from this point.

3. The 30 - 39 year old Indians had higher back lift scores than any age group while the 20 - 29 year olds and the 40 - 49 year olds had similar back strength scores. The oldest age group (50 - 62) had the lowest back lift scores.

4. There was a gradual drop in leg lift strength with increasing age with the exception that the 40 - 49 year old age group had the highest leg lift scores.

5. There was a gradual and continuous loss of arm strength and strength index scores with increasing age.

6. The amount of subcutaneous fat as measured by the total skinfold and percent body fat scores increased steadily with increasing age.

7. There was a gradual decrease in predicted maximal oxygen uptake with increasing age whereas the decrease in physical working capacity$_{170/kg.}$ was not evident until the oldest age group when a large drop occurred. This drop, however, was not statistically significant.

RESULTS OF SUBSIDIARY PROBLEMS

In an attempt to further describe the sample under study and localize differences on various parameters, the subjects in this study were grouped into the following categories:

(a) smokers and non-smokers

(b) drinkers and non-drinkers

(c) employed and not-employed

(d) bands

(e) provinces

It was hoped that the descriptive comparisons made would assist interested readers in determining where differences might occur based upon the classification variables above. No causative factors are implied as further study restricting the influence of extraneous variables would be required in order to justify cause-effect relationships. The remainder of this chapter presents a description of the findings of these additional comparisons. The reader is referred to chapter III and the first part of this chapter for the number of subjects used in these analyses.

Smoking Comparisons

Four t-tests using ANOV10 programs incorporating Hartley's F(max) test for difference between variance as well as Welch's t-prime adjustment of t-test values were conducted on vital capacity and one-second forced expiratory volume, on the following groups:

(a) Those who smoked one package per day or more and non-smokers.

(b) Those who smoked one-half package to one package per day and non-smokers.

In all four cases, the F-ratios for differences between variances were not significant and therefore the t-test results rather than the Welch t-prime adjustments were used in the analyses.

None of the t-ratios reached significance at the .05 level of significance. Table LXXVII presents a summary of the t-tests on the two smoking groupings and non-smokers.

In addition to the foregoing analyses, t-tests were conducted on smokers and non-smokers on predicted maximal oxygen uptake and physical working capacity$_{170}$. The two smoking groups were combined together for this analysis and no significant differences were found at the .05 level of significance. On the basis of the information available, no causative factors for these results can be identified and justified due to the fact that many extraneous variables which were not controlled may have been operating. However, these results are not compatible with other studies which have shown decreased pulmonary function in smokers as well as inferior maximal oxygen uptake scores.

TABLE LXXVII

T-TESTS ON SMOKERS AND NON-SMOKERS

A. One package per day and non-smokers

Parameter	Means: Smokers	Means: Non-smokers	Degrees of Freedom	t-ratio	t(df 52) at .05
Vital Capacity	4.13* $\pm$ .76	4.20 $\pm$ .79	52	-.312	2.010
$FEV_{1.0}$	3.23 $\pm$ .84	3.27 $\pm$ .90	57	-.157	2.010

B. One-half package per day and non-smokers

Parameter	Means: Smokers	Means: Non-smokers	Degrees of Freedom	t-ratio	t(df 57) at .05
Vital Capacity	4.26 $\pm$ .86	4.20 $\pm$ .79	52	.300	2.010
$FEV_{1.0}$	3.37 $\pm$ .84	3.27 $\pm$ .90	52	.429	2.010

* Mean $\pm$ standard deviation

Drinking Comparisons

Those who drank alcoholic beverages and those who did not were compared for significant differences using the same t-test procedure outlined for smokers and non-smokers. Comparisons were made on three parameters, including PWC_{170}, MVO_2, and percent body fat. The F(max) ratios for differences in variances were not considered appropriate due to the unequal number of subjects and thus Welch's t-prime adjustment was utilized in the test for differences on the three parameters. Only the t-prime value for percent body fat reached significance at the .05 level indicating a greater amount of body fat in the drinking group. This result is what might be expected considering the factor of drinking only. The others were non-significant. The results of these analyses are presented in Table LXXVIII.

TABLE LXXVIII

T-TESTS ON DRINKERS AND NON-DRINKERS

Parameter	Means		Welch t-prime Adjustment		
	(1) Drinkers	(2) Non-drinkers	Adjusted D. F.	t-prime	t-prime at .05
MVO_2 ml/kg/min.	35.74 ± 9.01* N = 106	33.75 ± 11.97 N = 20	23.23	0.705	2.069
Percent Body Fat	12.77 ± 6.62 N = 117	16.30 ± 8.09 N = 28	36.13	-2.141	2.031**
PWC_{170} (kpm/min.)	13.79 ± 3.21 N = 112	13.44 ± 4.55 N = 24	28.12	0.360	2.048

* Mean ± standard deviation
** Significant difference at .05 level

Employment Comparisons

Despite the fact that varied factors other than employment - non-employment would be operating, t-tests as described above were conducted on twelve parameters for significant differences between those who had been employed steadily for at least six months during the last year and those who had not been employed. In all cases the Hartley F(max) statistic showed significant differences in variances and thus the Welch t-prime adjustment test was utilized to test for differences. Those t-prime values marked with an asterisk in the table below, achieved significance at the .05 level of confidence.

The results in Table LXXIX show three significant differences between those employed and those not employed. These are (1) those employed had a significantly higher back lift mean score, (2) those employed had a significantly higher leg lift mean score, and (3) those employed had a significantly higher physical working capacity at a heart rate of 170 beats per minute (per kilogram-body weight).

Band Comparisons

One way analysis of variance tests were applied to test for significant differences between bands on twelve parameters. The program utilized (ANOV15) also incorporated computations of Bartlett's chi-square for homogenity of variance, Scheffe's multiple comparison of means, as well as Neuman-Keul's comparison between ordered means.

One of the assumptions underlying the analysis of variance is that the variances of the samples under scrutiny are equal. Consequently, the chi-square values were examined for significance

TABLE LXXIX

T-TESTS - EMPLOYED AND NON-EMPLOYED

Parameter	Means (1) Employed	Means (2) Non-employed	Welch t-prime Adjustment Adjusted D.F.	t-prime	t-prime at .05
Vital Capacity (liters)	4.29 ± .79* N = 71	4.16 ± .84 N = 63	127.96	0.875	1.960
$FEV_{1.0}$ (liters/sec.)	3.38 ± .86 N = 71	3.38 ± .88 N = 65	132.47	0.012	1.960
Left Grip (kg.)	48.61 ± 8.01 N = 70	47.55 ± 9.27 N = 65	126.93	0.709	1.960
Right Grip (kg.)	50.01 ± 7.65 N = 69	57.42 ± 7.38 N = 65	65.29	-0.804	1.996
Back Lift (lbs.)	355.98 ± 72.65 N = 66	324.33 ± 83.10 N = 65	126.21	2.327**	1.960
Leg Lift (lbs.)	792.13 ± 249.51 N = 67	704.77 ± 233.03 N = 65	129.82	2.080**	1.960
Arm Strength	242.48 ± 140.11 N = 67	240.35 ± 159.12 N = 63	123.63	0.081	1.960

* Mean ± standard deviation
** Significant at .05 level

TABLE LXXIX

(CONTINUED)

Parameter	Means		Welch t-prime Adjustment		
	(1) Employed	(2) Non-employed	Adjusted D.F.	t-prime	t-prime at .05
Strength Index	1856.11 ± 404.59 N = 66	1743.59 ± 410.8 N = 61	123.88	1.554	1.960
Total Skinfold (mm.)	69.74 ± 35.65 N = 69	75.14 ± 40.55 N = 66	129.16	-0.821	1.960
Percent Body Fat	12.71 + 6.42 N = 69	13.53 ± 7.46 N = 66	126.47	-0.681	1.960
MVO_2 (ml/kg/min.)	36.74 ± 10.10 N = 65	34.81 ± 8.41 N = 54	117.00	1.134	1.960
PWC_{170}/kg.	14.44 ± 3.71 N = 66	13.05 ± 3.11 N = 61	123.83	2.307**	1.960

** Significant at .05 level

at the .05 level of significance. The results of this examination appear in Table LXXX.

Four of the chi-square values achieved significance, indicating unequal variances for leg lift, total skinfold, percent body fat, and PWC_{170}. This, theoretically, should invalidate the resulting F-ratio generated by the analysis of vaiance. Despite this fact, this author decided to use the resulting analysis of variance computations on the basis of the fact that F-tests are robust with respect to departures from homogenity of variance and rather large departures are required to create a bias. This fact must be kept in mind when critically interpreting the results on the above four parameters, particularly the total skinfold parameter where the obtained chi-square value is quite large.

For purposes of brevity, presentation of the results of the analyses of variance and Neuman-Keul's comparisons between ordered means will be limited to those F-ratios achieving significance at the .05 level of confidence. The reader is referred to the appendix for the analysis of variance summaries for those parameters which were not significantly different between bands. These parameters include (1) vital capacity, (2) $FEV_{1.0}$, (3) arm strength, and (4) PWC_{170}. A table of the percentage of total males sampled in each band is also included in the appendix.

Table LXXXI presents a summary of the means $\pm$ standard deviations of all bands on each of the twelve parameters.

Left Grip - Bands

Table LXXXII depicts a summary of the one way analysis of variance on left grip strength between the eight bands tested. The resulting

TABLE LXXX

HOMOGENITY OF VARIANCE ON BANDS
ALL PARAMETERS

Parameter	Chi-square	D.F.*	Chi-square at .05
Vital Capacity	4.912	7	14.07
$FEV_{1.0}$	7.389	7	14.07
Left Grip	9.223	7	14.07
Right Grip	5.831	7	14.07
Back Lift	2.608	7	14.07
Leg Lift	15.9112**	7	14.07
Arm Strength	6.180	7	14.07
Strength Index	9.103	7	14.07
Total Skinfold	30.708**	7	14.07
Percent Body Fat	18.537**	7	14.07
MVO_2	9.535	7	14.07
PWC_{170}	17.273**	7	14.07

* Degrees of freedom = (N - 1)
** Significant at the .05 level

TABLE LXXXI

MEANS MATRIX FOR BANDS
ALL PARAMETERS

Band	Vital Capacity (liters)	$FEV_{1.0}$ (liters per sec.)	Left Grip (kg)	Right Grip (kg)	Back Lift (lbs)	Leg Lift (lbs)
1. Saddle Lake	4.18 (.69)* N = 24	3.37 (.74) N = 26	47.7 (6.49) N = 27	49.5 (7.34) N = 26	347.6 (67.9) N = 25	708.0 (166.1) N = 25
2. Drift-pile	4.61 (.76) N = 14	3.67 (.99) N = 14	45.2 (10.41) N = 14	43.6 (7.98) N = 14	344.2 (81.8) N = 13	626.9 (174.5) N = 13
3. Sturgeon Lake	4.42 (.93) N = 30	3.26 (1.06) N = 30	48.6 (10.26) N = 30	50.4 (10.1) N = 28	357.2 (73.2) N = 27	797.1 (249.1) N = 28
4. Nautley	4.15 (.63) N = 11	3.33 (.96) N = 11	48.5 (9.20) N = 11	50.1 (9.34) N = 10	315.5 (68.5) N = 11	774.5 (262.6) N = 11
5. Necoslie	4.11 (.80) N = 28	2.97 (.85) N = 29	43.6 (7.46) N = 30	45.7 (7.63) N = 31	287.5 (66.1) N = 30	584.5 (146.7) N = 30
6. Stoney Creek	4.50 (.69) N = 12	3.68 (.89) N = 12	48.6 (8.70) N = 12	52.0 (8.11) N = 12	340.4 (71.9) N = 13	801.3 (251.2) N = 12
7. Meadow Lake	4.25 (.85) N = 14	3.49 (.59) N = 14	53.9 (7.49) N = 13	53.8 (6.77) N = 14	397.7 (91.5) N = 13	897.5 (217.9) N = 14
8. Onion Lake	4.01 (.85) N = 51	3.25 (.87) N = 52	48.1 (7.47) N = 52	49.1 (8.24) N = 51	340.3 (74.9) N = 49	727.8 (256.9) N = 49
Overall	4.22 (.80)	3.31 (.89)	47.6 (8.45)	48.9 (8.24)	337.9 (77.2)	725.6 (232.9)

* Numbers in brackets are standard deviations.

TABLE LXXXI
(CONTINUED)

Band	Arm Strength	Strength Index	Total Skinfold (mm)	Percent Body Fat (%)	MVO_2 (ml/kg/ min.)	PWC_{170} (kpm/min)
1. Saddle Lake	187.8 (117.7) N = 25	1715 (252) N = 25	85.8 (34.3) N = 26	16.1 (5.9) N = 26	29.4 (8.8) N = 17	13.8 (4.1) N = 23
2. Driftpile	311.8 (160.2) N = 13	1756 (327) N = 13	54.4 (30.9) N = 13	9.0 (5.3) N = 14	42.6 (9.8) N = 13	16.1 (4.7) N = 13
3. Sturgeon Lake	238.6 (139.2) N = 28	1886 (414) N = 26	66.1 (20.5) N = 30	11.8 (4.3) N = 30	37.3 (7.1) N = 26	13.1 (2.7) N = 26
4. Nautley	233.5 (129.7) N = 11	1780 (422) N = 10	55.5 (20.2) N = 11	10.7 (4.7) N = 11	37.0 (8.3) N = 10	15.7 (4.7) N = 10
5. Necoslie	231.6 (172.5) N = 30	1542 (347) N = 30	64.5 (42.6) N = 30	11.9 (7.2) N = 28	36.5 (9.3) N = 26	14.1 (4.2) N = 26
6. Stoney Creek	313.6 (177.2) N = 12	1951 (410) N = 12	51.2 (18.8) N = 12	10.9 (4.4) N = 11	33.1 (5.0) N = 12	12.7 (1.8) N = 12
7. Meadow Lake	285.8 (170.5) N = 13	2115 (399) N = 12	64.0 (34.1) N = 14	12.0 (6.9) N = 14	36.2 (11.0) N = 12	13.2 (3.0) N = 14
8. Onion Lake	214.7 (136.2) N = 49	1737 (426) N = 48	85.2 (44.2) N = 51	15.7 (8.0) N = 51	33.6 (9.9) N = 40	13.4 (3.7) N = 45
Overall	237.3 (149.4)	1767 (400)	71.2 (36.9)	13.2 (6.8)	35.4 (9.3)	13.8 (3.7)

F-ratio is significant at the .05 level of significance.

TABLE LXXXII

ANALYSIS OF VARIANCE - LEFT GRIP
BANDS

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(7,181) at .05
Groups	1118.438	159.78	7	2.34	.026	2.07
Error	12377.125	68.38	181	-	-	-

In order to determine exactly where the difference was, the Neuman-Keul's comparison between ordered means was consulted. Only one of the differences between the ordered means was found significant, that between Meadow Lake Band in Saskatchewan and the Necoslie Band in British Columbia.

The Neuman-Keul's matrix and critical value computation summary appear in Table LXXXIII. The bands are numbered in accordance with the numbers in Table LXXXI.

Right Grip - Bands

A significant F-ratio at the .05 level was obtained between bands on right grip and the summarized analysis of variance appears in Table LXXXIV.

Utilizing the Neuman-Keul analysis to determine the location of the significant difference(s) the following results were obtained:

1. There is a significant difference in right grip strength between the Meadow Lake Band and the Driftpile Band.

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TABLE LXXXIII

NEUMAN-KEUL'S MATRIX - LEFT GRIP BANDS

Bands	7	6	3	4	8	1	2	5
5	10.213*	4.950	4.933	4.821	4.444	4.107	1.581	0.0
2	8.632	3.369	3.352	3.240	2.863	2.526	0.0	
1	6.105	0.843	0.826	0.714	0.336	0.0		
8	5.769	0.506	0.490	0.378	0.0			
4	5.392	0.129	0.112	0.0				
3	5.279	0.017	0.0					
6	5.263	0.0						
7	0.0							

Calculations r**	D.F.	Tabled Value (.01)	Multiplier	Critical Value
2	181	3.64	1.95148	7.098
3	181	4.12	1.95148	8.034
4	181	4.40	1.95148	8.580
5	181	4.60	1.95148	8.970
6	181	4.76	1.95148	9.292
7	181	4.88	1.95148	9.516
8	181	4.99	1.95148	9.7305

* Significant at .01 level

** r = number of steps apart on the ordered scale

2. There is a significant difference in right grip strength between the Stoney Creek Band and the Driftpile Band.

TABLE LXXXIV

ANALYSIS OF VARIANCE - RIGHT GRIP
BANDS

Source	Sum of Squares	Mean Square	Degree of Freedom	F-ratio	P	F(7, 178) at .05
Groups	1245.438	177.92	7	2.78	.009	2.07
Error	11377.187	63.92	178	-	-	-

Table LXXXV presents the Neuman-Keul matrix and computation of the critical values required at each r-value for right grip.

Leg Lift - Bands

The analysis of variance to test for differences in leg lift of the eight bands revealed an F-ratio significant at the .05 level. This summary appears in Table LXXXVI.

TABLE LXXXVI

ANALYSIS OF VARIANCE - LEG LIFT
BANDS

Source	Sum of Squares	Mean Square	Degree of Freedom	F-ratio	P	F(7, 174) at .05
Groups	1383824.0	197689.12	7	4.05	.0004	2.07
Error	8496272.0	48829.15	174	-	-	-

Differences between the Meadow Lake Band and the Necoslie Band

TABLE LXXXV

NEUMAN-KEUL'S MATRIX - RIGHT GRIP
BANDS

Bands	7	6	3	4	1	8	5	2
2	10.214*	8.345*	6.857	6.529	5.890	5.507	2.138	0.0
5	8.076	6.207	4.719	4.390	3.752	3.369	0.0	
8	4.707	2.838	1.350	1.022	0.383	0.0		
1	4.324	2.455	0.967	0.638	0.0			
4	3.686	1.817	0.329	0.0				
3	3.357	1.488	0.0					
6	1.869	0.0						
7	0.0							

Calculations r	D.F.	Tabled Value (.01)	Multiplier	Critical Value
2	178	3.64	1.90083	6.916
3	178	4.12	1.90083	7.728
4	178	4.40	1.90083	8.360
5	178	4.60	1.90083	8.740
6	178	4.76	1.90083	9.044
7	178	4.88	1.90083	9.272
8	178	4.99	1.90083	9.481

* Significant at .01 level.

as well as differences between Meadow Lake Band and the Driftpile Band on leg lift became apparent after the Newman-Keul's comparison of ordered means. The Meadow Lake Band had the highest mean leg lift score of the three bands. This matrix and the critical value computations are presented in Table LXXXVII.

Back Lift - Bands

A significant difference between bands on back lift is evident from the analysis of variance summary presented in Table LXXXVIII.

TABLE LXXXVIII

ANALYSIS OF VARIANCE - BACK LIFT
BANDS

Source	Sum of Squares	Mean Square	Degree of Freedom	F-ratio	P	F(7,133) at .05
Groups	141536.0	20219.43	7	3.34	.0008	2.07
Error	935808.0	5409.29	173	-	-	-

The Newman-Keul's comparison between ordered means pinpointed the location of the significant difference on back lift as being between the Meadow Lake Band and the Necoslie Band, with the former having the higher mean back lift score. None of the other band comparisons reached significance.

Critical value calculations and the Newman-Keul matrix appear in Table LXXXIX.

Strength Index - Bands

The eight bands were compared on the strength index parameter which is a composite score derived from the formula presented in

TABLE LXXXVII

NEWMAN-KEUL'S MATRIX - LEG LIFT
BANDS

Band	7	6	3	4	8	1	2	5
5	313.000*	216.750	212.643	190.045	143.316	123.500	42.423	0.0
2	217.577*	174.327	170.220	147.623	100.893	81.077	0.0	
1	189.500	93.250	89.143	66.545	19.816	0.0		
8	169.684	73.434	69.327	46.729	0.0			
4	122.955	26.705	22.597	0.0				
3	100.357	4.107	0.0					
6	96.250	0.0						
7	0.0							

Calculations r	D.F.	Tabled Value (.01)	Multiplier	Critical Value
2	173	3.64	52.52762	262.1147
3	173	4.12	52.52762	256.3464
4	173	4.40	52.52762	250.0428
5	173	4.60	52.52762	241.6380
6	173	4.76	52.52762	231.132
7	173	4.88	52.52762	216.4326
8	173	4.99	52.52762	191.2092

* Significant at .01 level

TABLE LXXXIX

NEWMAN-KEUL'S MATRIX - BACK LIFT
BANDS

Band	7	3	1	2	6	8	4	5
5	110.192*	69.722	60.100	56.731	52.885	52.806	27.954	0.0
4	82.238	41.768	32.146	28.776	24.930	24.852	0.0	
8	57.386	16.916	7.294	3.925	0.079	0.0		
6	57.308	16.838	7.215	3.846	0.0			
2	53.461	12.991	3.369	0.0				
1	50.092	9.622	0.0					
3	40.470	0.0						
7	0.0							

Calculations r	D.F.	Tabled Value (.01)	Multiplier	Critical Value
2	173	3.64	17.49095	63.7000
3	173	4.12	17.49095	72.1000
4	173	4.40	17.49095	77.0000
5	173	4.60	17.49095	80.5000
6	173	4.76	17.49095	83.3000
7	173	4.88	17.49095	85.4000
8	173	4.99	17.49095	87.325

* Significant at .01 level

chapter I, on page 4. The analysis of variance indicated a significant F-ratio and is summarized in Table XC.

TABLE XC

ANALYSIS OF VARIANCE - STRENGTH INDEX BANDS

Source	Sum of Squares	Mean Square	Degree of Freedom	F-ratio	P	F(7, 168) at .05
Groups	3857152.0	551021.69	7	3.81	.0007	2.07
Error	24311552.0	144711.56	168	-	-	-

The significant difference between bands was localized by the Newman-Keul's test as occurring between the Meadow Lake Band and the Necoslie Band with the former having a strength index mean score almost 600 units higher. Table XCI presents the matrix of ordered means comparisons as well as the critical value computations.

Total Skinfold - Bands

Total skinfold is a combination of the values obtained on the four sites measured (triceps, subscapular, chest, and abdomen) and the bands were compared for differences using an analysis of variance technique. This analysis, summarized in Table XCII revealed a significant difference between bands existed at the .05 level of signficance.

Further analysis using the Newman-Keul's Comparison between ordered means failed to locate where the difference(s) occurred. Further analysis using the Duncan approach may have revealed the location of the differences as this test is slightly less stringent

TABLE XCI

NEWMAN-KEUL'S MATRIX - STRENGTH INDEX
BANDS

Band	7	6	3	4	2	8	1	5
5	572.650*	408.817	344.156	237.833	213.964	194.900	173.253	0.0
1	399.397	235.563	170.903	64.580	40.711	21.647	0.0	
8	377.750	213.917	149.256	42.933	19.064	0.0		
2	358.686	194.853	130.192	23.869	0.0			
4	334.817	170.983	106.323	0.0				
3	228.494	64.660	0.0					
6	163.833	0.0						
7	0.0							

Calculations r	D.F.	Tabled Value (.01)	Multiplier	Critical Value
2	168	3.64	92.81314	337.820
3	168	4.12	92.81314	382.377
4	168	4.40	92.81314	408.364
5	168	4.60	92.81314	426.926
6	168	4.76	92.81314	441.776
7	168	4.88	92.81314	452.913
8	168	4.99	92.81314	463.122

* Significant at .01 level

[illegible]

than the Newman-Keul's procedure. However, this procedure was not attempted. Examination of the means would suggest that the significant difference(s) would occur between the Stoney Creek Band (smallest mean) and the Saddle Lake and Onion Lake Bands (each have almost identical means). This procedure is, obviously, statistically unjustified but for purposes of this study was considered adequate. (In addition, none of the mean differences reach significance when the .05 level is used instead of the .01 level.)

TABLE XCII

ANALYSIS OF VARIANCE - TOTAL SKINFOLD
BANDS

Source	Sum of Squares	Mean Square	Degree of Freedom	F-ratio	P	F(7, 179) at .05
Groups	29520.937	4217.27	7	3.34	.002	2.07
Error	226167.06	1263.50	179	-	-	-

Percent Body Fat - Bands

As would be expected from the previous result, the same situation arose with respect to the percent body fat comparisons between bands. The analysis of variance summary in Table XCIII reveals a significant F-ratio at the .05 level. Again, the Newman-Keul procedure failed to localize the differences. However, examining the means would suggest a difference might be significant between two of the Alberta bands, the Saddle Lake Band and the Driftpile Band with the former having a higher mean percentage of body fat. This result

[illegible]

[illegible]

[illegible]

[illegible]

is substantiated when the significance level is lowered to the .05 level from the .01 level for the interpretation of the Newman-Keul's test.

TABLE XCIII

ANALYSIS OF VARIANCE - PERCENT BODY FAT
BANDS

Source	Sum of Squares	Mean Square	Degree of Freedom	F-ratio	P	F(7, 177) at .05
Groups	1047.3906	149.63	7	3.58	.0012	2.07
Error	7403.6719	41.83	177	-	-	-

Predicted Maximal Oxygen Uptake - Bands

The analysis of variance for differences between bands on MVO_2 revealed a significant difference at the .05 level and is summarized in Table XCIV.

TABLE XCIV

ANALYSIS OF VARIANCE - MVO_2
BANDS

Source	Sum of Squares	Mean Square	Degree of Freedom	F-ratio	P	F(7, 148) at .05
Groups	1641.500	234.50	7	2.92	.006	2.08
Error	11877.687	80.25	148	-	-	-

The Newman-Keul's comparison between ordered means pinpointed the location of the significant differences between the Driftpile Band

and the Saddle Lake Band. The matrix for Newman-Keul and the calculations for establishing the critical values are presented in Table XCV.

Provincial Comparisons

The subjects were grouped according to the province in which they resided and tests for significant differences were made using a two-way analysis of variance as described earlier in this chapter when age-group comparisons were made. The reader is referred to Tables L to LXIX for the analyses of variance and the Scheffe multiple comparison of main effects for province for the summary of the results of provincial differences on the twelve parameters. The means matrix for the three provinces of British Columbia, Alberta, and Saskatchewan appear in Table XCVI. The following results were obtained on the provincial comparisons. (Those provinces marked with an asterisk achieved the highest scores.)

Vital Capacity:	Alberta* and British Columbia Saskatchewan and British Columbia* Alberta* and Saskatchewan
$FEV_{1.0}$:	British Columbia and Saskatchewan* British Columbia and Alberta* Alberta* and Saskatchewan
Left Grip:	British Columbia and Saskatchewan* Alberta and Saskatchewan*
Right Grip:	British Columbia and Saskatchewan* Alberta and Saskatchewan*
Leg Lift:	No significant provincial differences.
Arm Strength:	British Columbia*and Saskatchewan British Columbia* and Alberta
Strength Index:	British Columbia and Saskatchewan* Alberta and Saskatchewan*
Total Skinfold:	No significant provincial differences.

TABLE XCV

NEWMAN-KEUL'S MATRIX - MVO_2
BANDS

Band	7	6	5	4	2	1	3	8
8	13.204*	7.934	7.588	7.127	6.755	4.213	3.672	0.0
3	9.532	4.263	3.917	3.455	3.083	0.542	0.0	
1	8.990	3.721	3.375	2.913	2.542	0.0		
2	6.449	1.179	0.833	0.372	0.0			
4	6.077	0.808	0.462	0.0				
5	5.615	0.346	0.0					
6	5.269	0.0						
7	0.0							

Calculations r	D.F.	Tabled Value (.01)	Multiplier	Critical Value
2	148	3.64	2.24931	8.19
3	148	4.12	2.24931	9.27
4	148	4.40	2.24931	9.98
5	148	4.60	2.24931	10.35
6	148	4.76	2.24931	10.71
7	148	4.88	2.24931	10.98
8	148	4.99	2.24931	11.228

* Significant at .01 level

NOTE: Due to insertion of the computer cards in the opposite order from previous analyses, band numbers are as follows: 1. Onion Lake, 2. Meadow Lake, 3. Stoney Creek, 4. Necoslie, 5. Nautley, 6. Sturgeon Lake, 7. Driftpile, and 8. Saddle Lake.

TABLE XCVI

MEANS MATRIX FOR PROVINCES
ALL PARAMETERS

Province	Vital Capacity (liters)	$FEV_{1.0}$ (liters/sec)	Left Grip (kg)	Right Grip (kg)	Back Lift (lbs)	Leg Lift (lbs)
British Columbia	4.21 (.75)* N = 51	3.21 (.91) N = 52	45.8 (8.3) N = 53	48.1 (8.4) N = 52	305.6 (71.0) N = 53	676.1 (223.7) N = 54
Alberta	4.37 (.82) N = 68	3.38 (.94) N = 70	47.5 (9.0) N = 70	48.7 (8.9) N = 68	351.9 (72.1) N = 64	728.3 (212.9) N = 65
Saskatchewan	4.06 (.82) N = 65	3.29 (.82) N = 66	49.2 (7.8) N = 65	49.9 (7.5) N = 65	353.9 (79.8) N = 62	765.5 (257.1) N = 63
Overall	4.22 (.80) N = 184	3.30 (.89) N = 187	47.6 (8.5) N = 188	48.9 (8.3) N = 185	338.9 (77.0) N = 179	725.7 (233.1) N = 182

* Standard Deviation

TABLE XCVI

(CONTINUED)

Province	Arm Strength	Strength Index	Total Skinfold (mm)	Percent Body Fat %	MVO_2 (ml/kg/min)	PWC_{170}/kg (kpm/min)
British Columbia	250.6	1682.3	59.6	11.3	35.8	14.2
	(166.3)	(408.1)	(34.6)	(6.2)	(8.2)	(3.5)
	N = 53	N = 52	N = 53	N = 53	N = 48	N = 48
Alberta	233.8	1793.2	70.7	12.9	36.2	14.0
	(141.3)	(344.9)	(30.6)	(5.7)	(9.6)	(3.8)
	N = 66	N = 64	N = 70	N = 70	N = 56	N = 62
Saskatchewan	229.6	1812.7	80.6	14.9	34.2	13.5
	(145.5)	(444.1)	(42.9)	(7.8)	(10.1)	(3.5)
	N = 62	N = 60	N = 65	N = 65	N = 52	N = 58
Overall	237.3	1767.1	71.0	13.2	35.4	13.9
	(149.4)	(400.1)	(36.9)	(6.7)	(9.3)	(3.6)
	N = 181	N = 176	N = 188	N = 188	N = 156	N = 168

Percent Body Fat: British Columbia and Saskatchewan*
Alberta andSaskatchewan*
British Columbia and Alberta*

$PWC_{170/kg.}$ British Columbia* and Saskatchewan

The Scheffe comparison of main effects on $PWC_{170/kg.}$ appears in Table XCVII.

TABLE XCVII

SCHEFFE COMPARISON OF MAIN EFFECTS - $PWC_{170/kg.}$
PROVINCE

Province	Contrast	F-ratio	Probability
1 - 2	.998	1.236	.293
1 - 3	2.500	5.864*	.003
2 - 3	1.500	1.911	.151

* Significant at .10 level

The Saskatchewan sample appears to be somewhat stronger than the other provincial samples, however, this is probably due to the fact that the very active subjects in the Meadow Lake Band (who were significantly stronger than the other bands)were part of the Saskatchewan grouping. This bias could cause the provincial differences in strength

Graphical Representation of Age Group and Provincial Means

As an aid to visualization of the data presented in tables of the means of the age groups and provinces on twelve parameters measured, the following six pages present the mean scores in graphical form.

SUMMARY OF SUBSIDIARY COMPARISONS

The foregoing sections have shown a number of significant

the following graphical representations are presented.

FIGURE I

VITAL CAPACITY

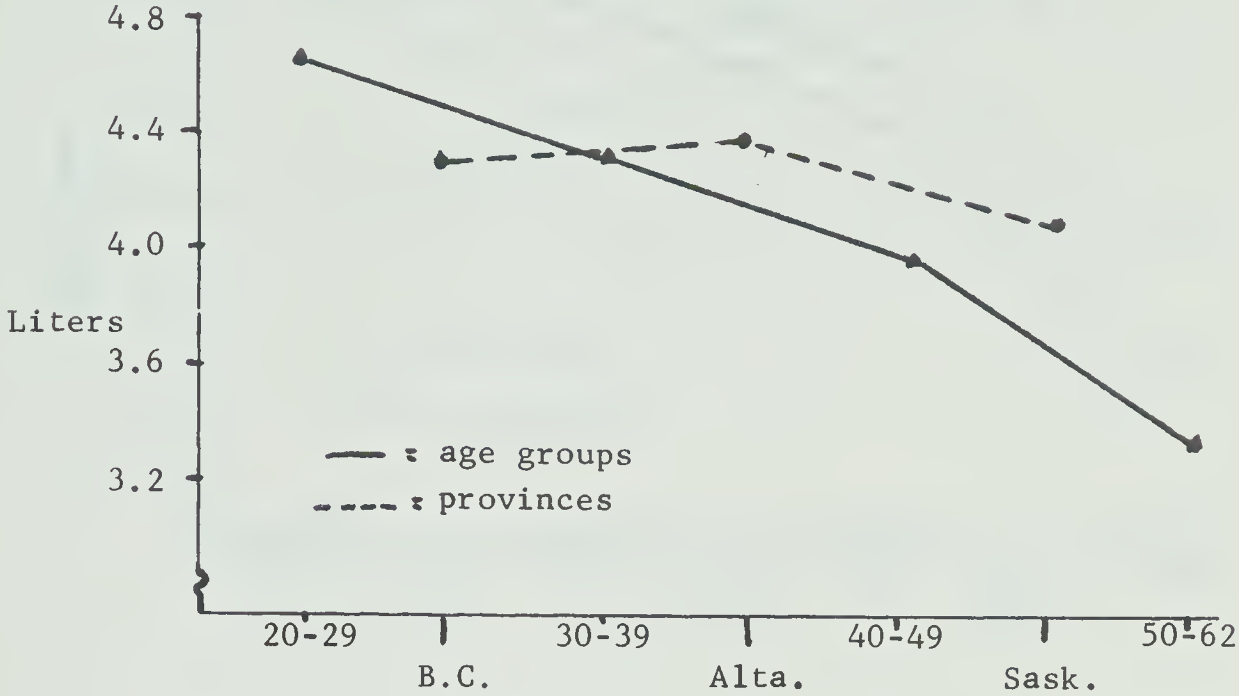


FIGURE II
$FEV_{1.0}$

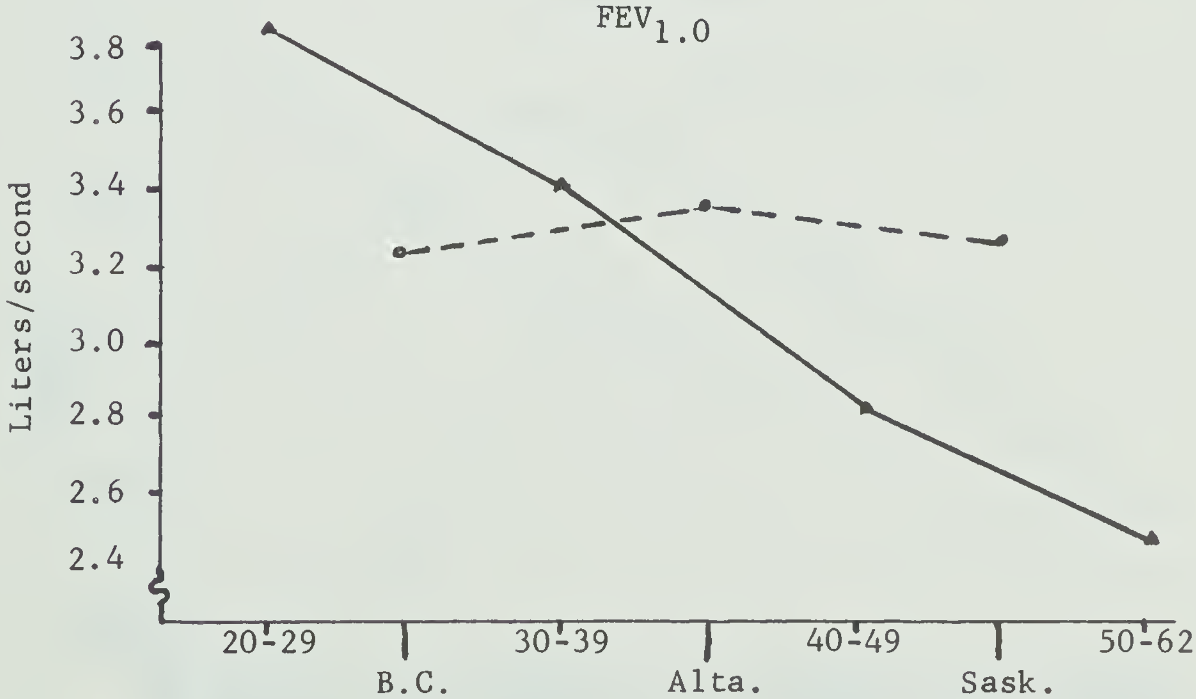


FIGURE III

LEFT AND RIGHT GRIP

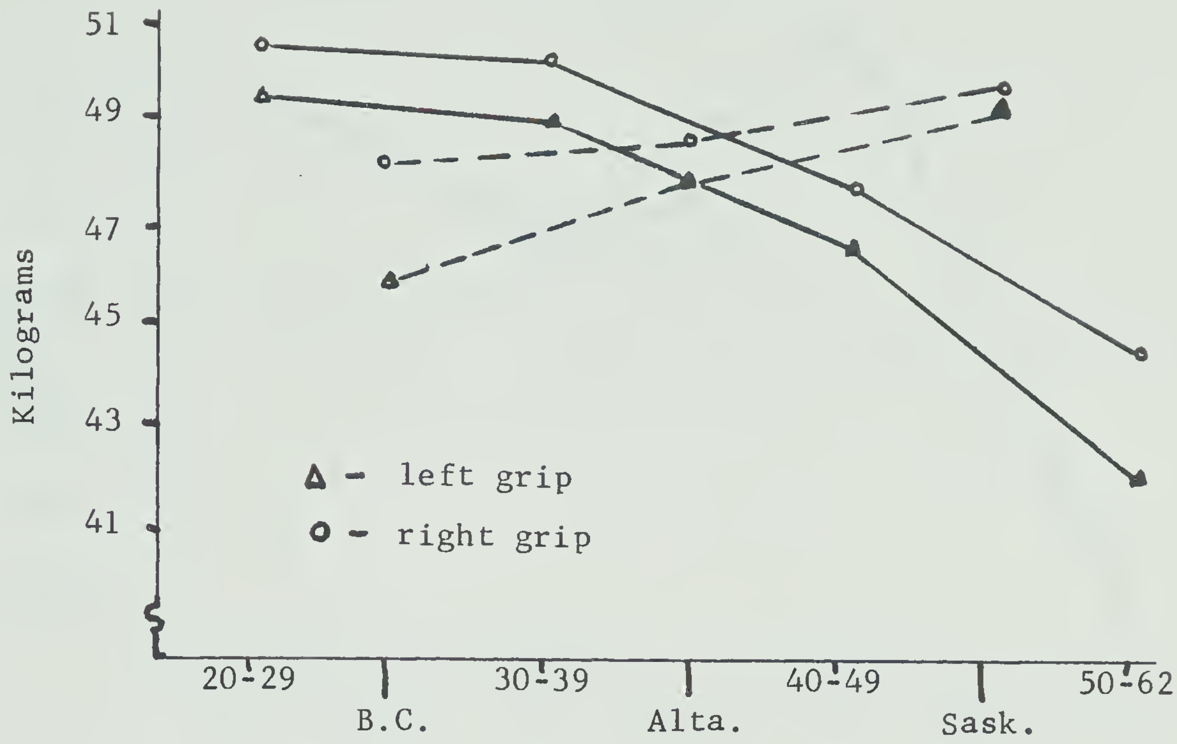


FIGURE IV

BACK LIFT

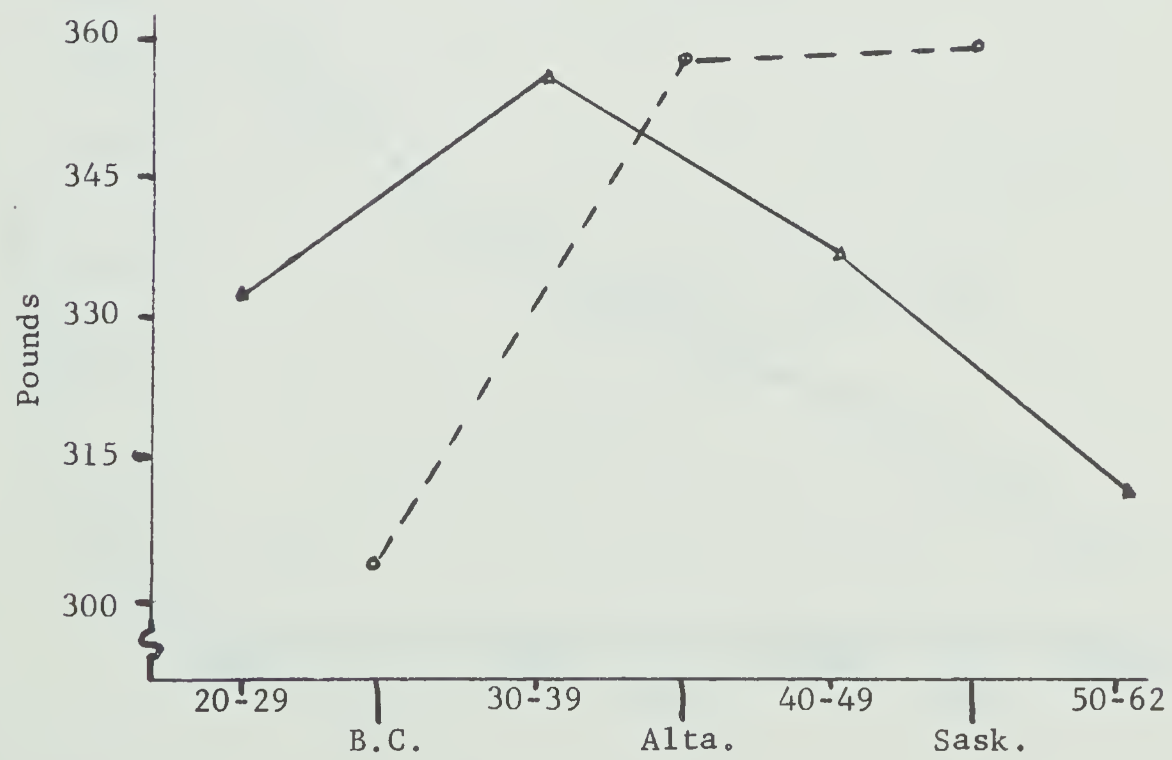


FIGURE V

LEG LIFT

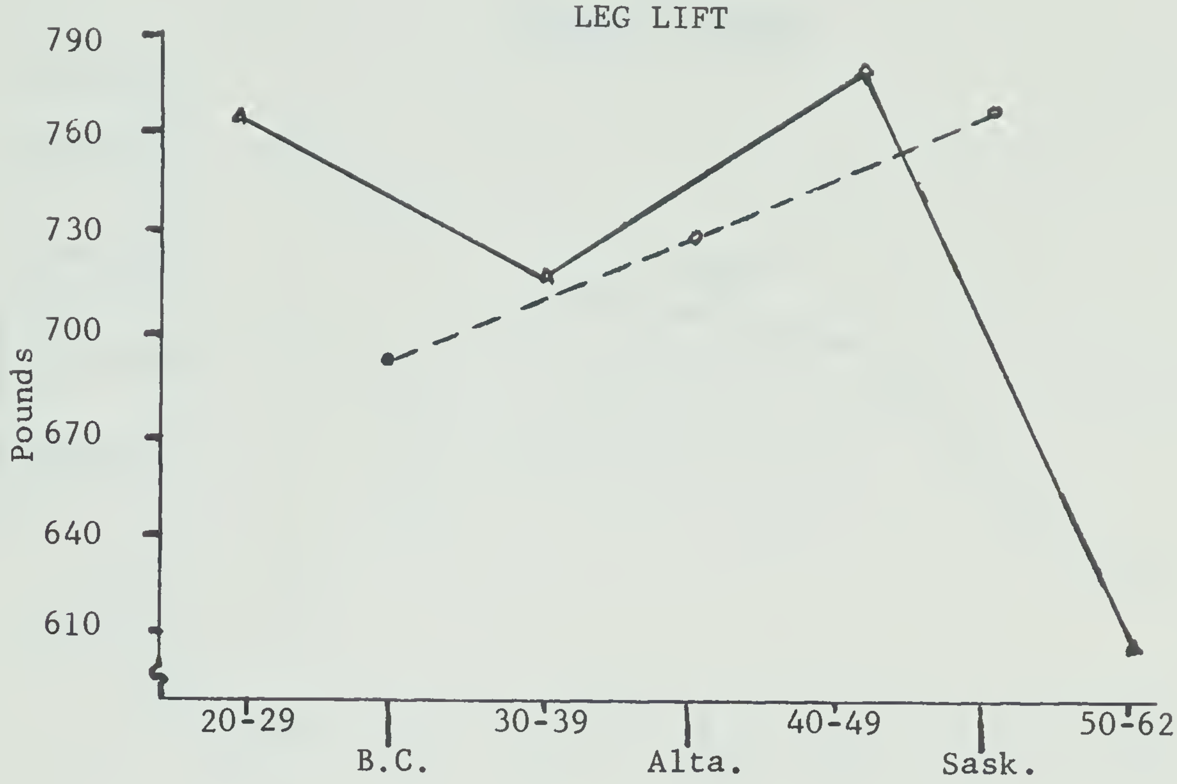


FIGURE VI

ARM STRENGTH

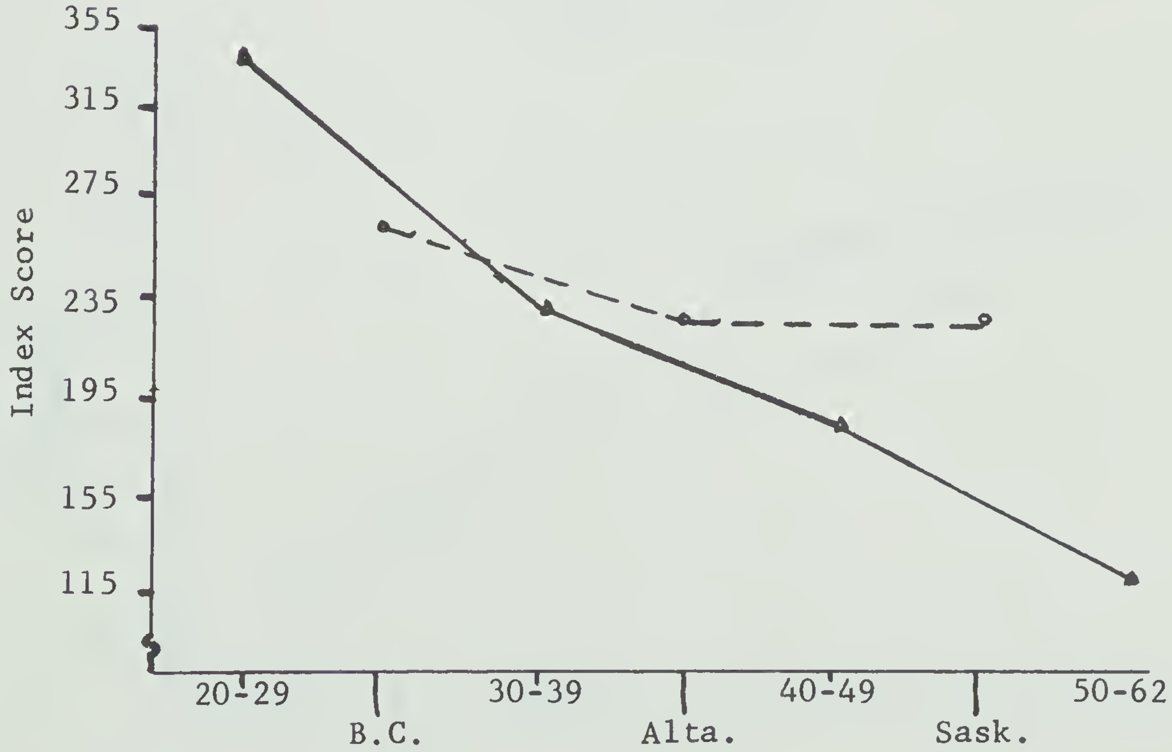


FIGURE VII

STRENGTH INDEX

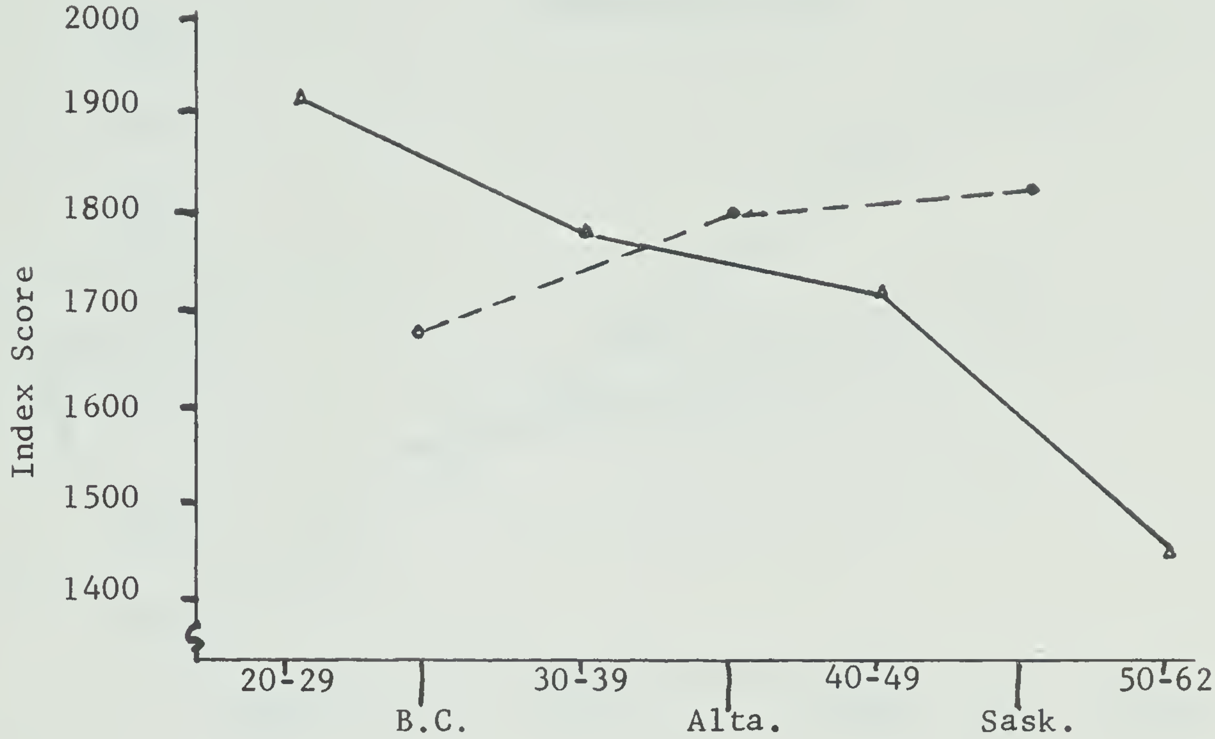


FIGURE VIII

TOTAL SKINFOLD

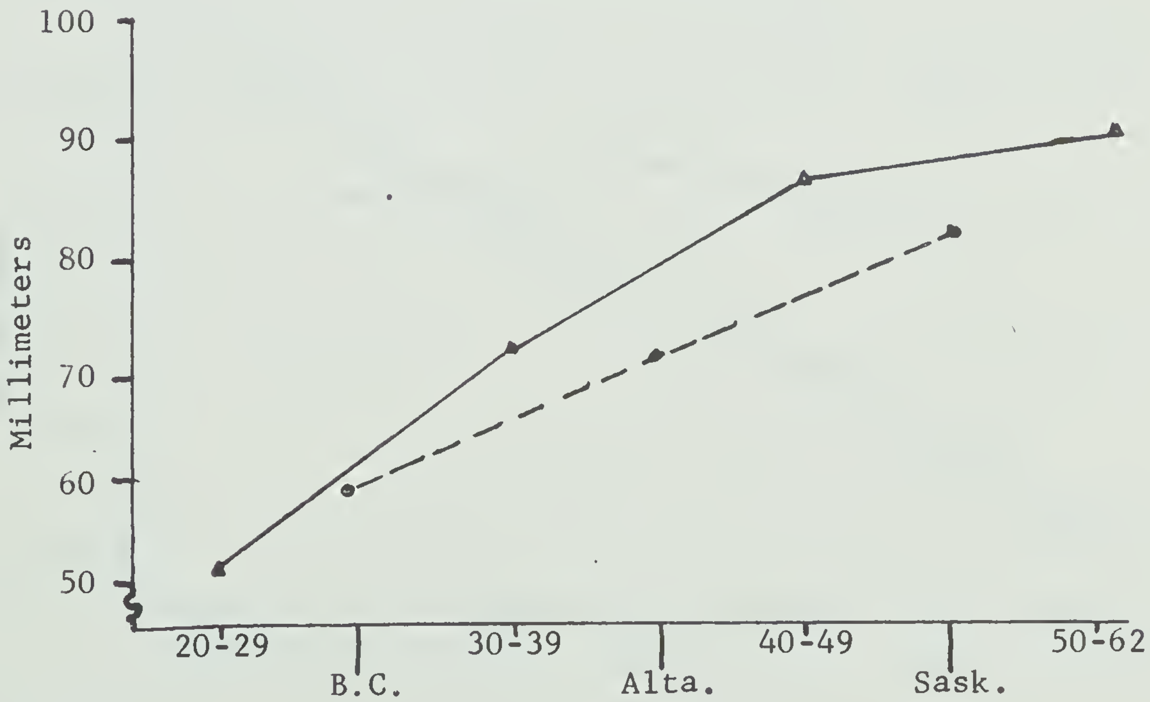


FIGURE IX

PERCENT BODY FAT

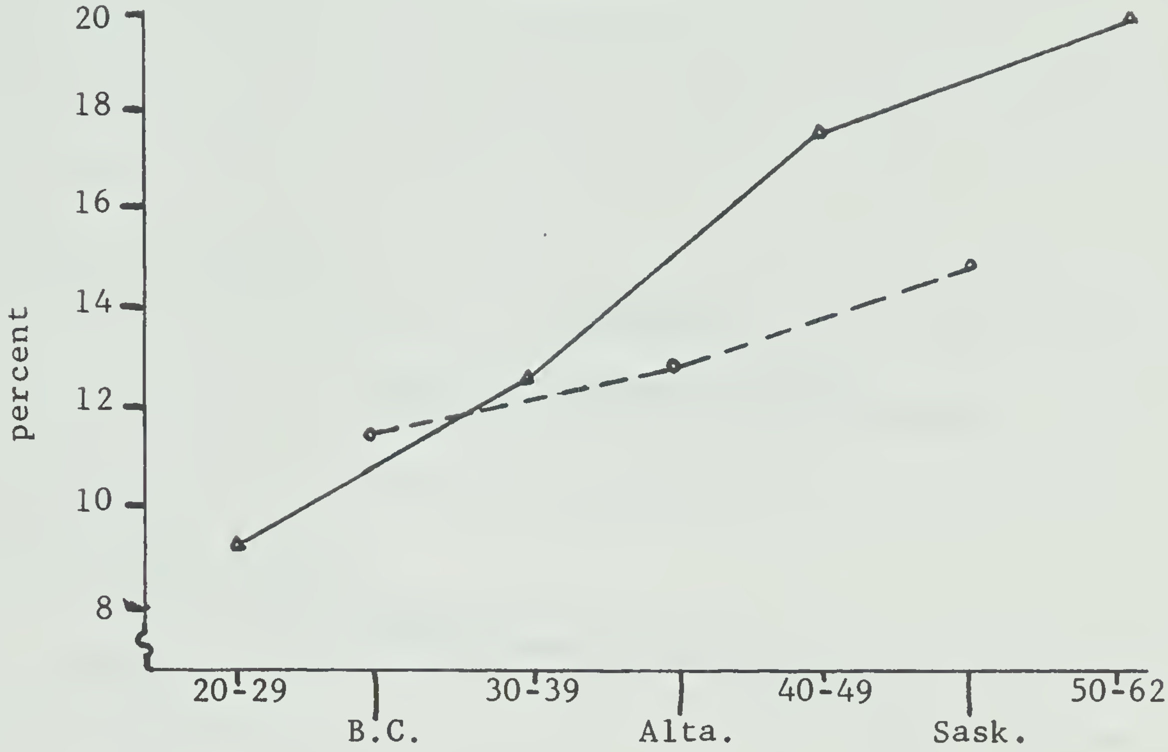


FIGURE X

MAXIMAL OXYGEN UPTAKE

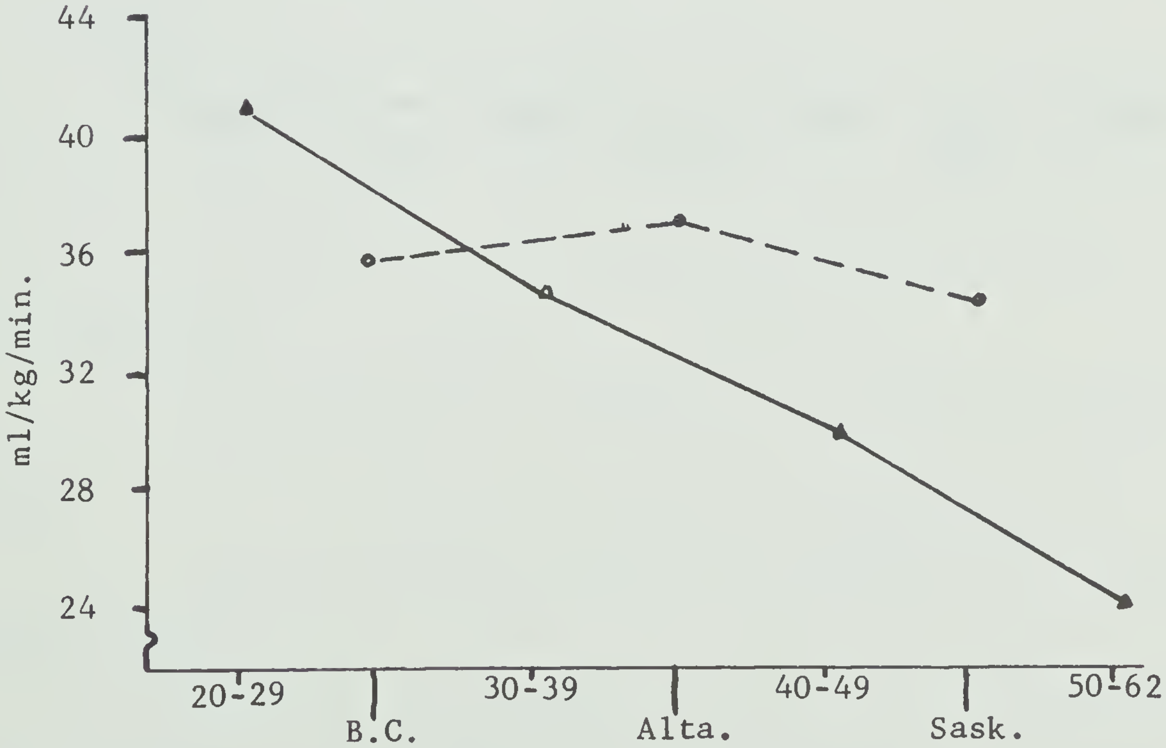
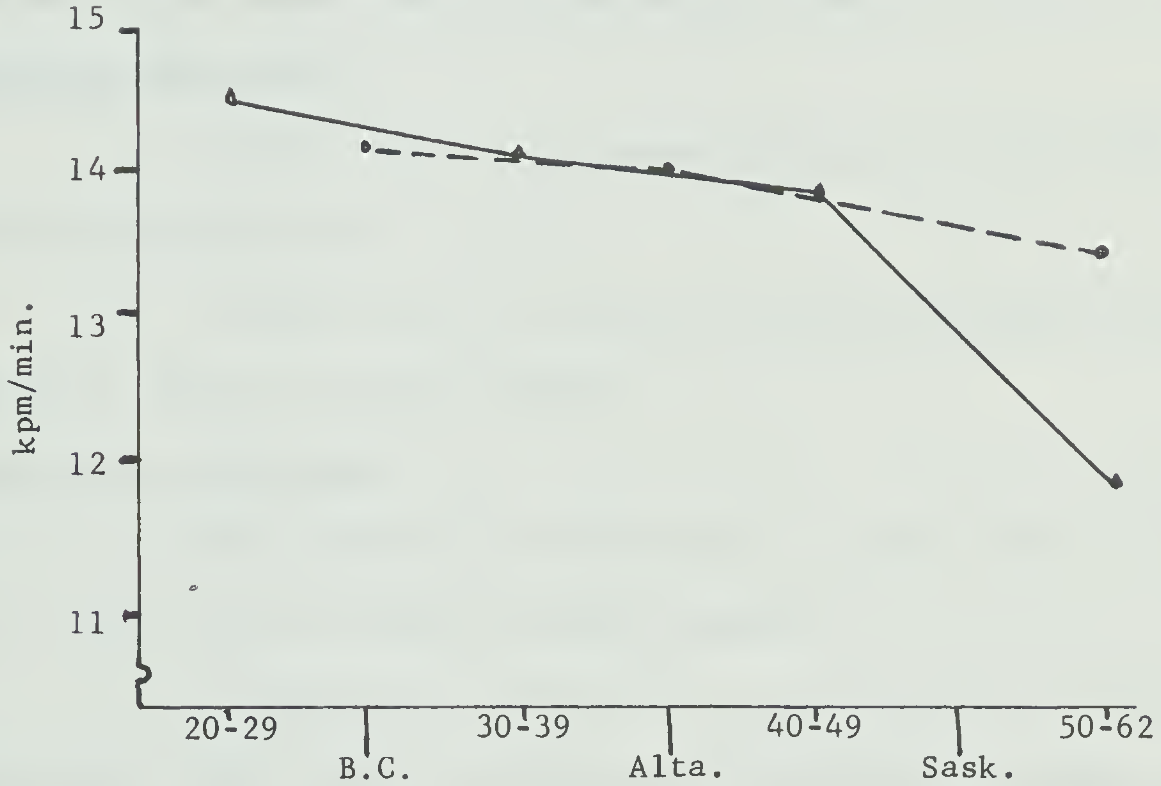


FIGURE XI

PHYSICAL WORKING CAPACITY$_{170}$/kg.



differences between the various classification variables used in this study. For purposes of clarification and synthesis, these results are summarized below. Those classifications possessing an asterisk where significant differences exist, had the highest score on the test item.

<u>Smoking Comparisons</u>

1. No significant differences between smokers and non-smokers on vital capacity, one-second forced expiratory volume, predicted maximal oxygen uptake and physical working capacity.

<u>Drinking Comparisons</u>

1. Drinkers had a significantly higher percentage body fat than non-drinkers.

2. No significant differences on predicted maximal oxygen uptake or physical working capacity.

<u>Employment Comparisons</u>

1. Those employed had significantly higher scores on leg lift, back lift and physical working capacity.

2. No significant differences on vital capacity, forced expiratory volume, left or right grip, arm strength, strength index, total skinfold, percent body fat and predicted maximal oxygen uptake.

<u>Band Comparisons</u>

1. Vital Capacity - No significant differences between bands.

2. Forced Expiratory Volume$_{1.0}$ - No significant differences between bands.

3. Left Grip - Significant difference between Meadow Lake Band* and Necoslie Band.

4. Right Grip - Significant differences between:

   Meadow Lake Band* and Driftpile Band
   Stoney Creek Band* and Driftpile Band

5. Leg Lift - Significant differences between:

   Meadow Lake Band* and Necoslie Band
   Meadow Lake Band* and Driftpile Band

6. Back Lift - Significant differences between Meadow Lake Band* and Necoslie Band.

7. Arm Strength - No significant differences.

8. Strength Index - Significant difference between Meadow Lake Band* and Necoslie Band.

9. Total Skinfold - Significant differences but Neuman-Keuls failed to pinpoint this difference.

10. Percent Body Fat - Significant differences but Neuman-Keuls failed to pinpoint them.

11. Predicted Maximal Oxygen Uptake - Significant difference between the Driftpile Band* and the Saddle Lake Band.

12. Physical Working Capacity - No significant differences.

<u>Provincial Comparisons</u>

1. Vital Capacity - Significant differences between provinces:

   Alberta* and British Columbia
   Saskatchewan and British Columbia*
   Alberta* and Saskatchewan

2. Forced Expiratory Volume$_{1.0}$ - Significant differences between:

   British Columbia and Saskatchewan*
   British Columbia and Alberta*
   Alberta and Saskatchewan*

3. Left Grip - Significant differences between:

   British Columbia and Saskatchewan*
   Alberta and Saskatchewan*

4. Right Grip - Significant differences between:

British Columbia and Saskatchewan*
Alberta and Saskatchewan*

5. Arm Strength - Significant differences between:

British Columbia* and Saskatchewan
British Columbia* and Alberta

6. Leg Lift - No significant differences shown.

7. Back Lift - Interaction effect significant and no further analyses made.

8. Strength Index - Significant differences between:

British Columbia and Saskatchewan*
Alberta and Saskatchewan*

9. Total Skinfold - No significant differences.

10. Percent Body Fat - Significant differences between:

British Columbia and Saskatchewan*
British Columbia and Alberta*
Alberta and Saskatchewan*

11. Predicted Maximal Oxygen Uptake - Interaction effect present and no further analysis made.

12. Physical Working Capacity - Significant provincial difference between British Columbia* and Saskatchewan.

CHAPTER V

SUMMARY AND CONCLUSIONS

PURPOSE

It was the purpose of this study to establish and describe the physical fitness status of Western Canadian Indian males living on government reserves above 53.5°N latitude, in the three western provinces of British Columbia, Alberta and Saskatchewan. In addition, a comparison of the mean scores of selected constituents of physical fitness were made between other ethnic groups around the world.

SUBJECTS

The final number of bands tested did not represent a proportionate random sample as was originally intended due to the lack of response of some bands. The final sample included three bands from British Columbia, three from Alberta and two from Saskatchewan.

A total of 189 volunteer male subjects between the ages of twenty to sixty years of age participated in this study. Of these, 144 subjects completed all items in the test battery while the remainder were missing scores on one or more items due to handicaps, injuries or refusal to take certain portions of the test. No subject was forced to complete the tests, however, all were encouraged to do so. Approximately 147 subjects completed a questionnaire seeking information on work habits, recreational pursuits, nutritional and medical status, as well as smoking and drinking habits.

PROCEDURES

All bands were reached by car and testing conducted during the period July 13, 1971 to August 13, 1971. Upon arriving at the band settlement, contact was made with the chief and/or Department of National Health and Welfare nurse and a person to act as interpreter and assist in recruiting subjects was secured. In all cases, these persons were paid for their work.

Subjects arrived at the testing center which was usually set up in the band office or nurse's office and were asked to remove all clothing except their slacks. Height and weight were then recorded and the test items were administered in the order presented on pages seven and eight. At the completion of the physical fitness tests, the subjects responded to the questionnaire. The test items were administered to each subject by the same practiced investigator in order to eliminate this source of experimental error.

CONCLUSIONS

Within the limitations of this study the following conclusions appear justified:

1. No significant differences existed between smokers and non-smokers on vital capacity, one-second forced expiratory volume, predicted maximal oxygen uptake and physical working capacity$_{170/kg}$.

2. Drinkers had a significantly higher percentage of body fat than non-drinkers but did not differ on predicted maximal oxygen uptake or physical working capacity$_{170/kg}$.

3. Those persons who were employed had significantly higher

scores on leg lift, back lift, and physical working capacity but did not differ on vital capacity, one-second forced expiratory volume, left or right grip, arm strength, strength index, total skinfold, percent body fat or predicted maximal oxygen uptake.

4. There was no significant differences between the bands tested on vital capacity, one-second forced expiratory volume, arm strength or physical working capacity$_{170/kg}$.

5. The Meadow Lake band had the highest mean scores on the following test items and were significantly different from the bands indicated to the right of the item following:

(a) Left Grip - Necoslie Band
(b) Right Grip - Driftpile Band
(c) Leg Lift - Necoslie Band and Driftpile Band
(d) Back Lift - Necoslie Band
(e) Strength Index - Necoslie Band

6. The Stoney Creek band had significantly higher mean score on right grip than the Driftpile Band.

7. The Driftpile Band had a significantly higher mean score on predicted maximal oxygen uptake than the Saddle Lake Band.

8. There were no significant age group differences on physical working capacity$_{170/kg}$.

9. Age group 50 - 62 scored the poorest on the following test items and were significantly different from the age group(s) indicated to the right of the test item following:

(a) Vital Capacity - age group 20 - 29
age group 30 - 39

(b) Forced Expiratory Volume$_{1.0}$ - age group 20 - 29
age group 30 - 39
age group 40 - 49

(c) Left Grip - age group 20 - 29
age group 30 - 39

(d) Right Grip - age group 20 - 29

(e) Arm Strength - age group 20 - 29
age group 30 - 39

(f) Leg Lift - age group 20 - 29

(g) Strength Index - age group 20 - 29
age group 30 - 39
age group 40 - 49

(h) Percent Body Fat - age group 20 - 29

10. There were significant differences between all three provinces on the following test items:

(a) Vital capacity
(b) Forced expiratory volume$_{1.0}$
(c) Percent body fat

11. There were significant differences in the mean scores of Saskatchewan and Alberta on left grip, right grip and strength index with Saskatchewan having the highest score in all cases.

12. There were significant differences in mean scores between British Columbia and Saskatchewan and British Columbia and Alberta on arm strength with British Columbia having the highest score in both cases.

13. There were significant differences between Saskatchewan and British Columbia on physical working capacity$_{170/kg.}$ with British Columbia having the highest mean score.

14. There were no significant provincial differences on leg lift and total skinfold.

The following conclusions are not statistically justified but were evident from examination of the results of other studies in the world literature.

15. The Indian males in this study do not appear to differ

from other ethnic groups reported in this study on maximal oxygen uptake.

16. The Indian males in age group 50 - 62 appear to have lower scores on vital capacity than other ethnic groups reported in this study.

17. The Indian males in this study do not appear to have significantly higher percentage body fat than other ethnic groups reported in this study.

18. The Indian males as a group appear to have lower grip strength than average Canadians of the same age and lower strength index than is normal for their age and weight.

19. The highest correlations occurred between vital capacity and one-second forced expiratory volume (r =.66), left and right grip and strength index (r = .70), back lift and strength index (r = .84), and percent body fat and maximal oxygen uptake (r = -.71).

RECOMMENDATIONS

In light of the results of this study, the following recommendations are made:

1. Additional studies be carried out on Indian males living in more remote parts of western Canada as well as other areas of Canada.

2. A study be made of the physical fitness status of Indian females.

3. That further more comprehensive strength and lung function tests be administered to the bands included in this study.

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APPENDIX

FACULTY OF PHYSICAL EDUCATION

THE UNIVERSITY OF ALBERTA
EDMONTON 7, CANADA

June 23, 1971

Mr. Ronald Seymour, Chief
Fort George Band
3, 901 Ahbau Street
Prince George, B.C.

Dear Mr. Seymour:

Within the next two weeks, Dr. Mohan Singh and I will be conducting a study of the physical fitness of northern Indian males in Saskatchewan, Alberta and British Columbia. We are pleased to announce that your band has been selected to participate in this study.

Our study will concern itself with males between the ages of 20 and 60 years and will involve testing each person on a few strength measures plus riding a stationary bicycle.

We anticipate that the testing will take about 20 minutes per person and the information it provides will be very valuable in determining the physical fitness levels of Indian males.

You would be of great assistance to us by supplying the following information:

1. Is it possible to reach your band by car?

2. Is there a convenient central location such as a schoolhouse or hall where we could conduct the testing?

3. Could you contact males in your band between the ages of 20 and 60 years who might be willing to volunteer as subjects for the tests?

4. Do most of the people speak English or is there an interpreter who might assist us for a small fee?

5. When would it be convenient to visit your area? We plan to travel by car and would like to arrive sometime in late June or early July, 1971.

6. Is there a phone number where you could be reached?

7. Any other information which you feel would be of assistance in planning this project.

We sincerely appreciate your kind cooperation and look forward to hearing from you as soon as possible. Looking forward to seeing you soon.

FACULTY OF PHYSICAL EDUCATION - UNIVERSITY OF ALBERTA

PHYSICAL FITNESS OF NORTHERN CANADIAN INDIANS

DATA SHEET

Name: ______ Subject No: ______ Date: ______ Place: ______

Age: ______ Year Height: ______ Inches Weight: ______ lbs. ______ kg.

STRENGTH INDEX

Vital Capacity	Rt. Grip (mean)	Lt. Grip (mean)	Back Lift (mean)	Leg Lift (mean)	Dips (no. done)	Chins (no. done)	Arm Strength	Strength Index
______ liters	______ kg.	______ kg.	______ lb.	______ lb.				

SKIN FOLD

Scapular	Nipple	Triceps	Abdomen	Total
______ mm.	______ mm.	______ mm.	______ mm.	______ mm.

SPECIFIC GRAVITY

______

PERCENT BODY FAT

______ %

$FEV_{1.0}$ ______ 1/sec.

PWC

	Resting	1	2	3	4	Resistance	5	6	7	8	Resistance	9	10	11	12	Resistance
Heart Rate																

	1	2	3	4	Total	5	6	7	8	Total	9	10	11	12	Total
Pedal Revs															

PWC ______ kpm.

PWC/kgm. ______

PWC_{140} ______

MVO_2 ______ 1./min.

MVO_2 ______ ml./kg./min.

PWC_{170} ______

REMARKS

FACULTY OF PHYSICAL EDUCATION
UNIVERSITY OF ALBERTA

PHYSICAL FITNESS OF NORTHERN CANADIAN INDIANS

QUESTIONNAIRE

Name: ______________________ Subject No.: ______ Date: ______________

Place: ______________________ Age: ______ Years Height: ______ Inches Weight: ______ lbs. ______ kg.

A. WORK HABITS

Type of Work:

Fishing (commercial) ______

Trapping ______

Handicrafts ______

Farming ______

Cattle Raising ______

Other ______________ Nature of Work ______________

B. RECREATIONAL ACTIVITIES

	Yes	No	How Often
Reading			
Television			
Handicrafts			
Hobbies			
Sports			
Doing nothing			
Vigorous Work			

Employed? ______ By Whom? ______________ Nature of Work ______________

Is your york: (a) regular all year around: ______

(b) seasonal? ______ when? ______________

Remarks: ______________________________

C. NUTRITION

Do you eat:

	Yes	No	How Often Per Week
Potatoes			
Cooked vegetables			
Eggs			
Bread			
Fresh vegetables			
Fresh fruit			
Canned fruit			
Beef			
Pork			
Fish			
Chicken			
Milk			
Vitamins			
Candy			

Remarks: ______________________________

QUESTIONNAIRE CONT.

D. Do you smoke? Yes: _____ No: _____

How much? ______________________________

E. Do you drink alcoholic beverages? Yes: _____ No: _____

How often? ______________________________

F. MEDICAL STATUS

When did you have your last medical examination? ______________________________

Have you had any serious illnesses lately? Yes: _____ No: _____

When? ______________________________

What? ______________________________

Results of medical history from available information: ______________________________

____

____

____

Source of above: ______________________________

____

G. OVERALL EVALUATION

1. Work Habits
   - (a) sedentary _____
   - (b) moderately active _____
   - (c) active _____
2. Recreational Activities
   - (a) sedentary _____
   - (b) moderately active _____
   - (c) active _____
3. Nutritional Status
   - (a) adequate diet _____
   - (b) diet lacking in: protein _____
     - fat _____
     - carbohydrates _____
     - vitamins _____
4. Medical status
   - (a) healthy _____
   - (b) not healthy for the following reasons: ______________________________

____

____

____

Examiner

HEART RATE FROM ECG - RATE = 25/mm/sec.

Distance of 3 Beats	Heart Rate	Distance of 3 Beats	Heart Rate	Distance of 3 Beats	Heart Rate
17	265	36.5	123	56	80
17.5	257	37	122	56.5	80
18	250	37.5	120	57	79
18.5	243	38	118	57.5	78
19	237	38.5	117	58	78
19.5	231	39	115	58.5	77
20	225	39.5	114	59	76
20.5	220	40	113	59.5	76
21	214	40.5	111	60	75
21.5	209	41	110	60.5	74
22	204	41.5	108	61	74
22.5	200	42	107	61.5	73
23	195	42.5	106	62	73
23.5	191	43	105	62.5	72
24	187	43.5	103	63	71
24.5	184	44	102	63.5	71
25	180	44.5	101	64	70
25.5	176	45	100	64.5	70
26	173	45.5	99	65	69
26.5	170	46	98	65.5	69
27	167	46.5	97	66	68
27.5	164	47	96	66.5	68
28	161	47.5	95	67	67
28.5	158	48	94	67.5	67
29	155	48.5	93	68	66
29.5	153	49	92	68.5	66
30	150	49.5	91	69	65
30.5	148	50	90	69.5	65
31	145	50.5	89	70	64
31.5	143	51	88	71	63
32	141	51.5	87	72	62
32.5	138	52	87	73	61
33	136	52.5	86	74	61
33.5	134	53	85	75	60
34	132	53.5	84	76	60
34.5	130	54	83	77	59
35	129	54.5	83	78	58
35.5	127	55	82	79	57
36	125	55.5	81	80	55

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TABLE XCVIII

INTERCORRELATION MATRIX - ALL PARAMETERS

Parameters	1 Vital Capacity	2 Right Grip	3 Left Grip	4 Leg Lift	5 Back Lift	6 Arm Strength	7 Strength Index	8 Total Skinfold	9 $FEV_{1.0}$	10 Percent Body Fat	11 MVO_2	12 PWC_{170}
1	1.00*											
2	.39*	1.00										
3	.35*	.77*	1.00									
4	.25*	.64*	.65*	1.00								
5	.28*	.58*	.53*	.52*	1.00							
6	.48*	.24*	.25*	.08	.14	1.00						
7	.55*	.70*	.70*	.63*	.84*	.59*	1.00					
8	-.19*	.08	.04	.09	.04	-.34*	-.12	1.00				
9	.66*	.35*	.31*	.19*	.29*	.45*	.51*	-.09	1.00			
10	.41*	.09	.06	.14	.08	-.64*	-.23*	.60*	-.34*	1.00		
11	.28*	.10	.07	.11	.03	.44*	.18*	-.39*	.29*	-.71*	1.00	
12	-.03	.23*	.23*	.17*	.17*	-.03	-.18*	-.10	-.03	-.14	.10	1.00

* Significant at .01 level ($t_{.01}$ with 142 D.F. = 1.96)

TABLE XCIX

ANALYSIS OF VARIANCE - VITAL CAPACITY BANDS

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(7, 176) at .05
Groups	6.96899	1.00	7	1.56	.150	2.07
Error	112.3825	0.64	176			

TABLE C

ANALYSIS OF VARIANCE - $FEV_{1.0}$ BANDS

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(7, 176) at .05
Groups	7.4978	1.07	7	1.38	.216	2.07
Error	139.7902	0.78	180			

TABLE CI

ANALYSIS OF VARIANCE - ARM STRENGTH BANDS

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(7,173) at .05
Groups	259888.0	37125.71	7	1.70	.112	2.07
Error	3779663.0	21847.76	173			

TABLE CII

ANALYSIS OF VARIANCE - $PWC_{170/kg.}$
BANDS

Source	Sum of Squares	Mean Square	Degrees of Freedom	F-ratio	P	F(7, 161) at .05
Groups	145.5703	20.80	7	1.51	.165	2.07
Error	2210.5156	13.73	161			

TABLE CIII

MEAN AGES, HEIGHTS AND WEIGHTS
PROVINCES AND BANDS

Band	N	Mean Age	Mean Height	Mean Weight
Saddle Lake	24	41.46	70.03	180.30
Driftpile	14	24.57	69.14	166.43
Sturgeon Lake	30	31.69	69.41	179.31
Necoslie	31	36.70	69.07	163.7
Nautley	11	34.73	68.9	164.91
Stoney Creek	13	39.08	68.92	157.92
Onion Lake	52	38.73	69.27	176.51
Meadow Lake	14	32.90	69.47	168.67
Province				
British Columbia	54	36.84	68.96	162.18
Alberta	70	32.57	69.53	175.35
Saskatchewan	65	35.81	69.37	172.59

TABLE CIV

LEG DYNAMOMETER CALIBRATIONS

Applied Force	Dynamometer Reading
50	40
100	85
150	140
200	195
250	235
300	295
350	350
400	400
450	450
500	500
550	550
600	595
650	650
700	695
750	750
800	800
850	850
900	900
950	950
1000	995
1100	1095
1200	1195
1300	1300
1400	1395
1500	1495
1600	1600
1700	1700
1800	1800
1900	1895
2000	1995
2100	2095
2200	2195
2300	2300

TABLE CV

PERCENTAGE OF TOTAL MALES SAMPLED IN EACH BAND

Band	Total Males*	Total in Sample	Percentage
Stoney Creek	70	13	18.57%
Meadow Lake	125	14	11.20%
Necoslie	200	31	15.5%
Saddle Lake	600	24	4.0%
Driftpile	200	14	7.0%
Sturgeon Lake	250	30	12.0%
Onion Lake	300	52	17.33%
Nautley	100	11	11.0%
Totals	1845	189	10.2%

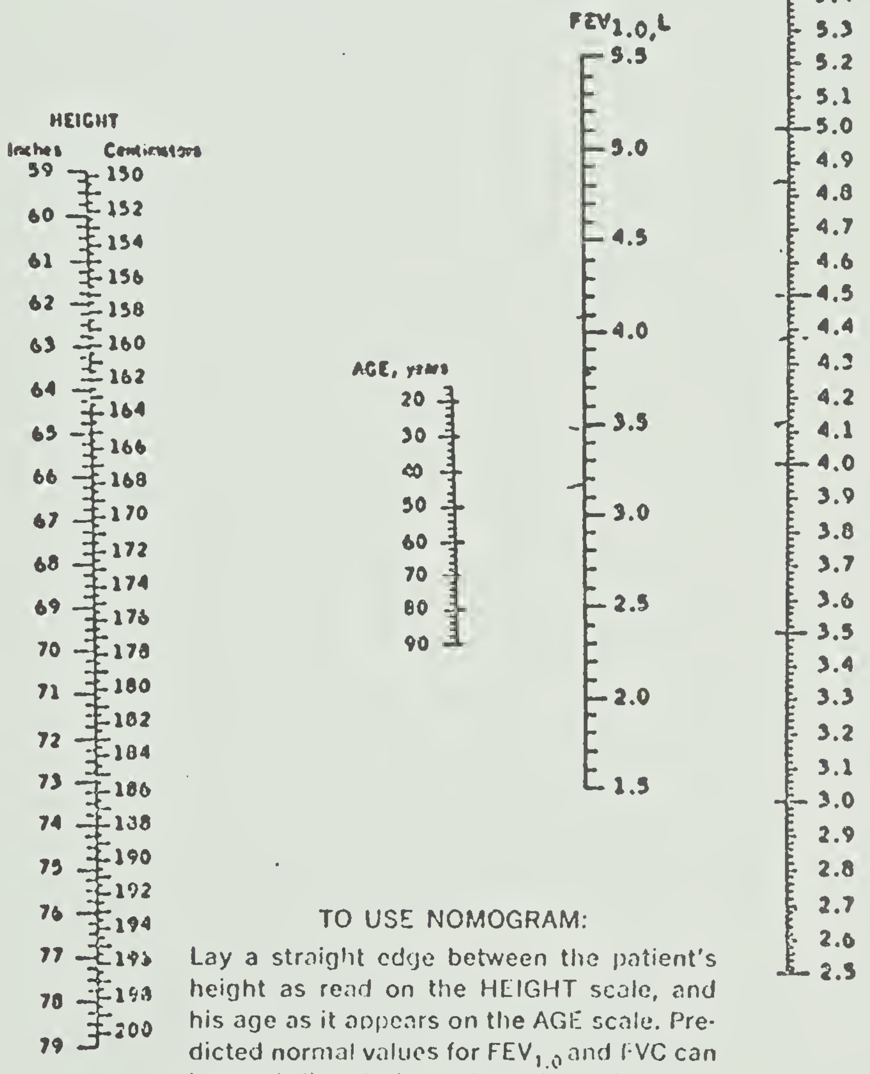
*These figures are approximations as exact figures were unavailable.

V.A.-ARMY COOPERATIVE STUDY: PREDICTION NOMOGRAM (ATPS)
SPIROMETRIC VALUES IN NORMAL MALES

This nomogram has been modified for use at room temperature (approx. 25° C). Thus the observed volumes may be compared directly with these predicted normal values without temperature correction.

$FEV_{1.0}$ = 1 second forced expiratory volume
Standard Error of Estimate = 0.52L

FVC = Forced vital capacity
Standard Error of Estimate = 0.58L



TO USE NOMOGRAM:

Lay a straight edge between the patient's height as read on the HEIGHT scale, and his age as it appears on the AGE scale. Predicted normal values for $FEV_{1.0}$ and FVC can be read directly from the points where the straight edge crosses the two right hand scales.

Adapted from Kory, Callahan, Boren and Syner, Am. J. Med. 30:243-58, 1961

FIG. 13—This nomogram for men is suitable for spirometers not requiring a correction for temperature of the expired air.